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Omori et al.

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(54) **DISK DRIVE**

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See application file for complete search history.

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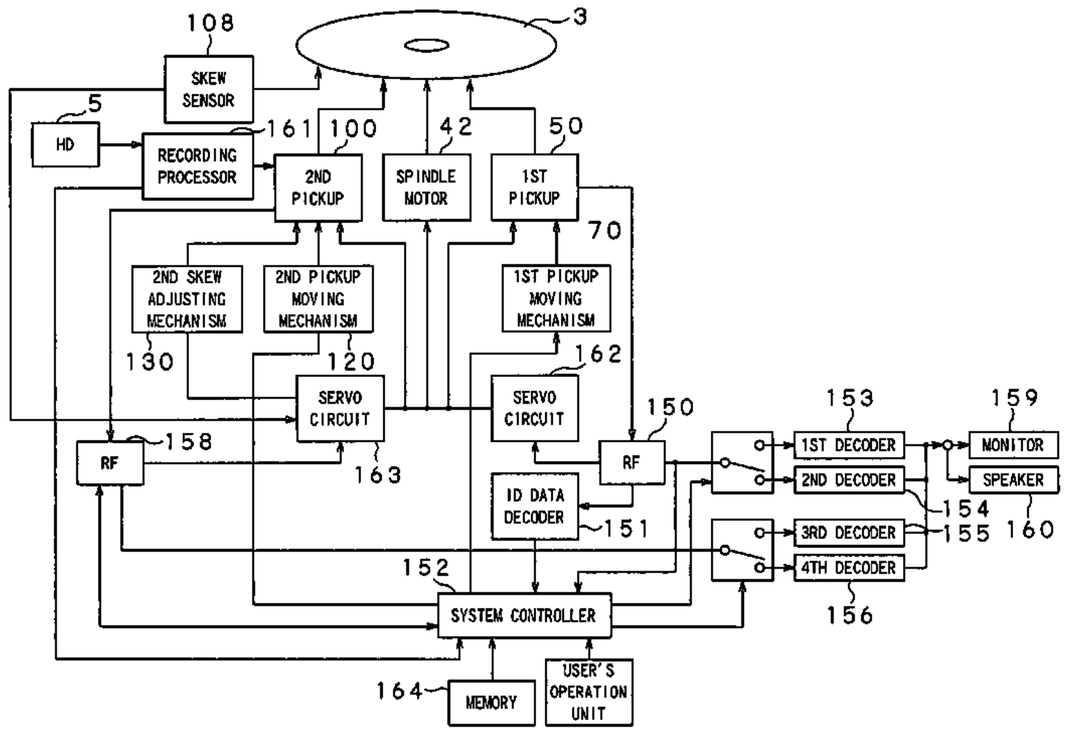
(74) *Attorney, Agent, or Firm*—Wolf, Greenfield & Sacks, P.C.

(57) **ABSTRACT**

There is provided a disk drive including a base chassis, a first optical pickup mechanism including a disk rotation drive disposed on the base chassis, first optical pickup unit to write and/or read data to and/or from a first optical disk and a first pickup moving mechanism to move the first optical pickup unit radially of the first optical disk, a second optical pickup mechanism disposed opposite to the first optical pickup mechanism and including a second optical pickup unit to write and/or read data to and/or from a second optical disk and a second pickup moving mechanism to move the second optical pickup unit radially of the second optical disk, and a controlling means for detecting the movement of one of the optical pickup units and moving the other optical pickup unit to make weight balancing of the base chassis. Thus, the base chassis weight is balanced while one of the two optical pickup units is being moved.

8 Claims, 8 Drawing Sheets



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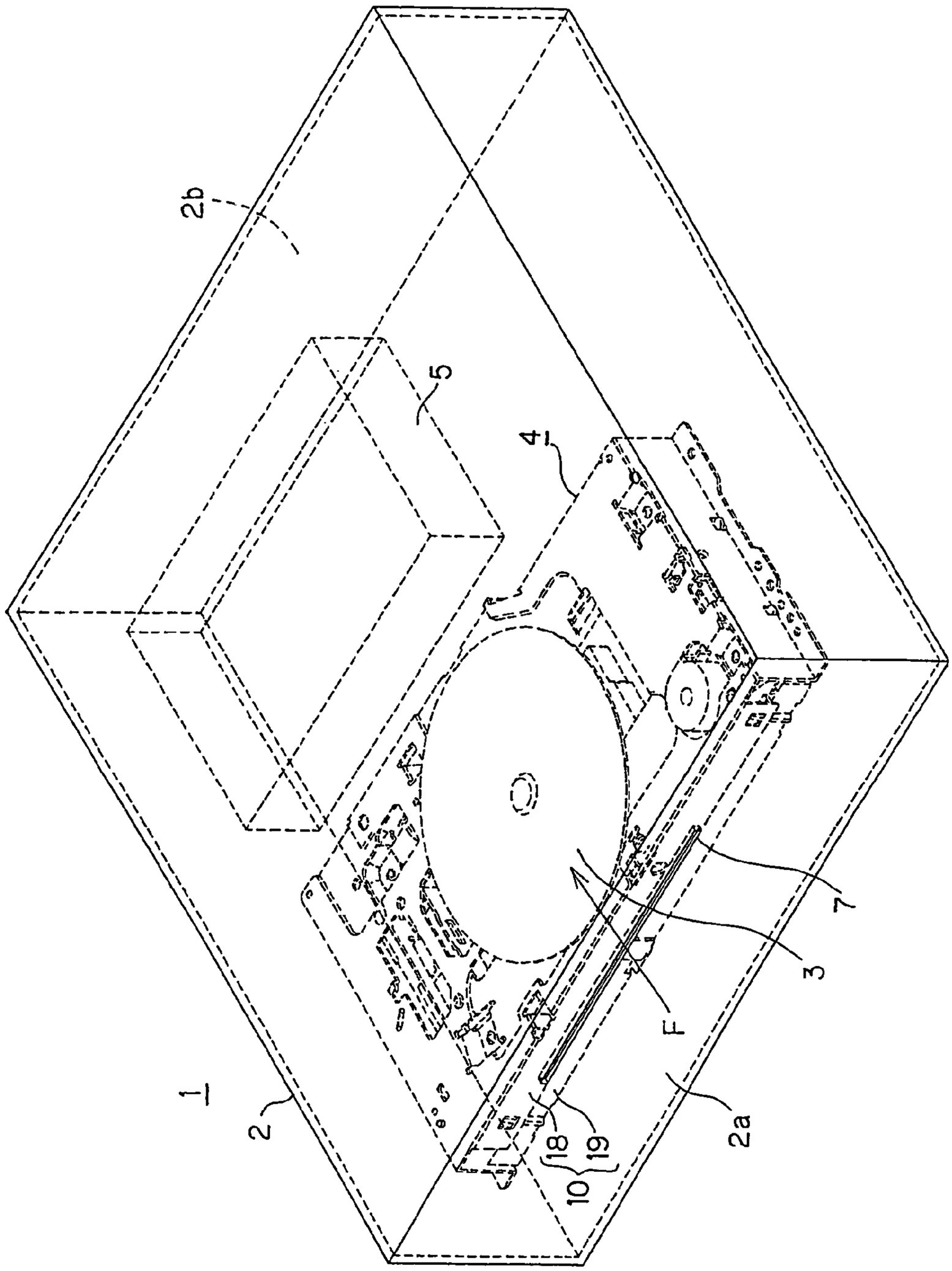


FIG.1

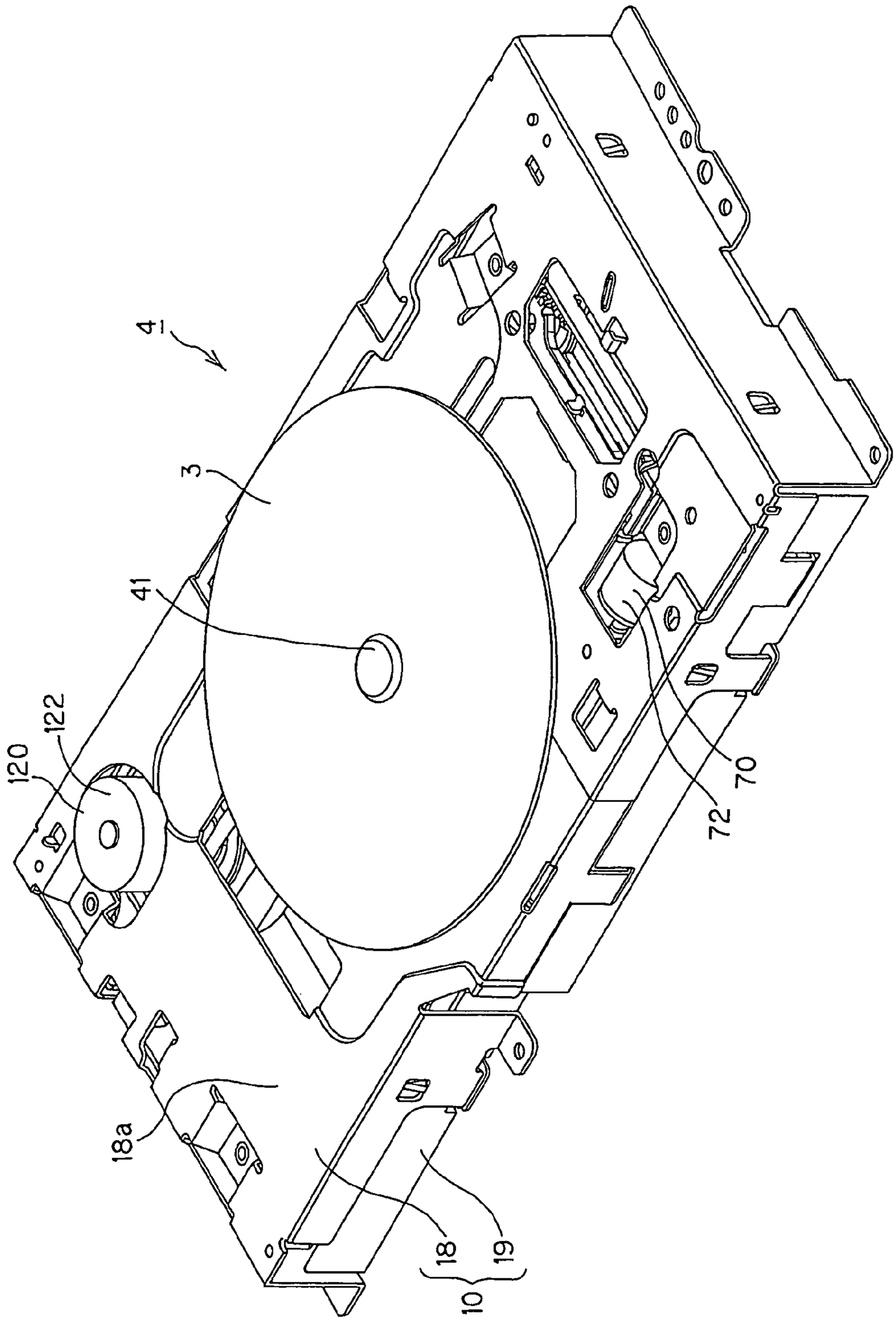
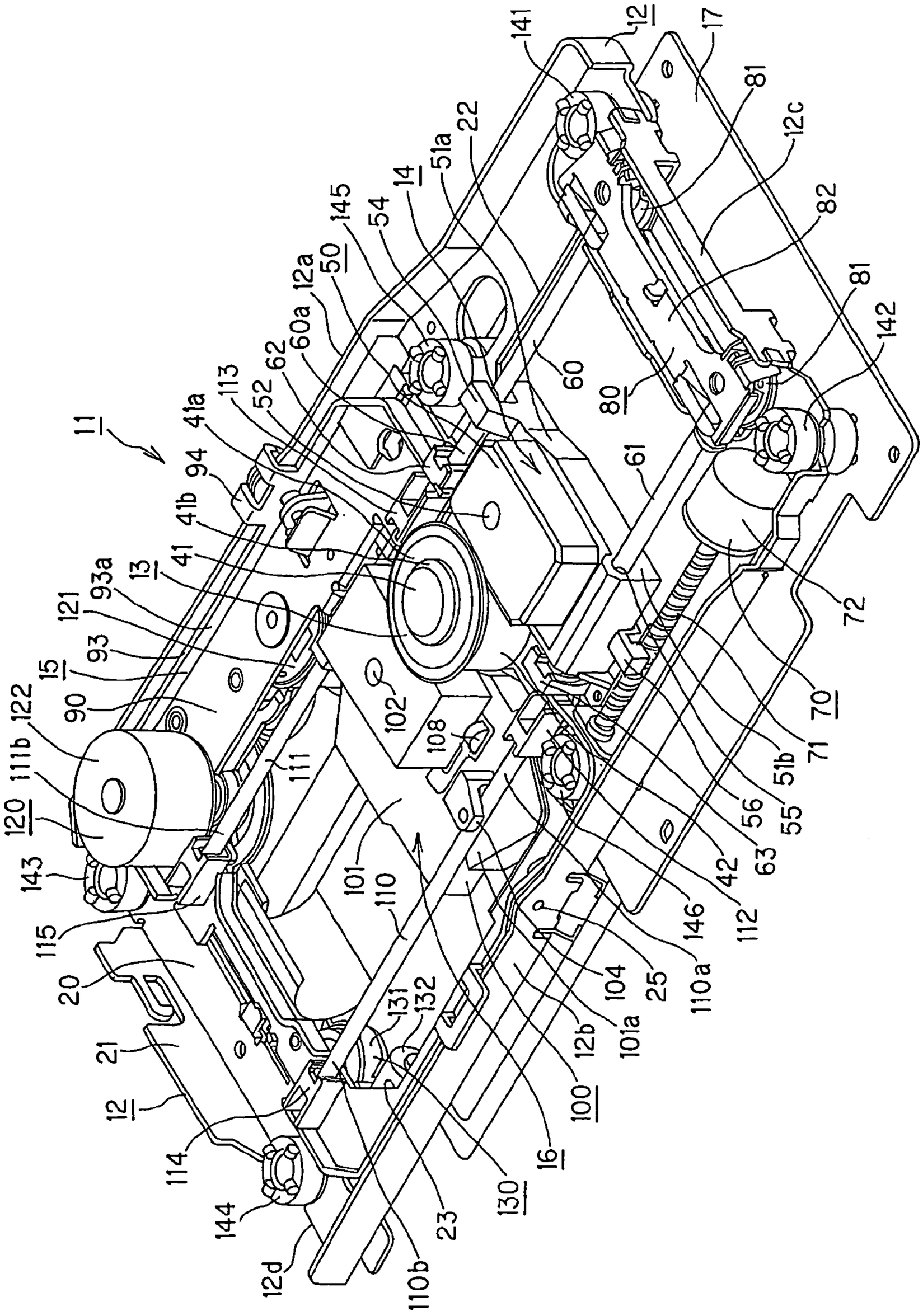


FIG.2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110b
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111b
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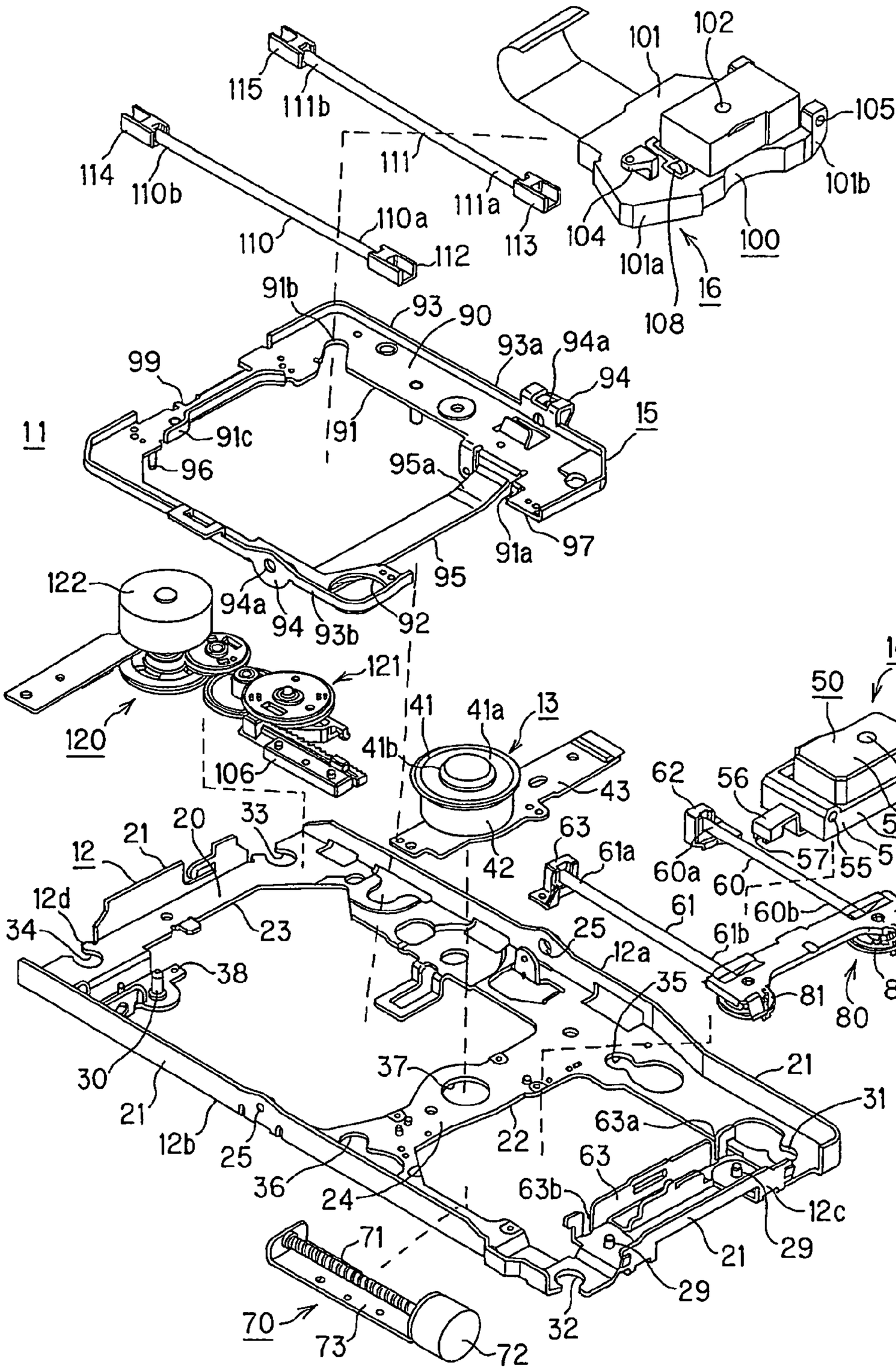
12a
12b
12c
12d

FIG.3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101a
16
108
93a
94a
94
99
15
11
91c
91
96
95a
91a
97
95
122
94a
94
93b
92
121
120
106
14
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41a
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41b
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51a
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61a
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55
51b
51
60a
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82
12
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33
12d
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60b
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12a
61b
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63a
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63b
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72

FIG.4

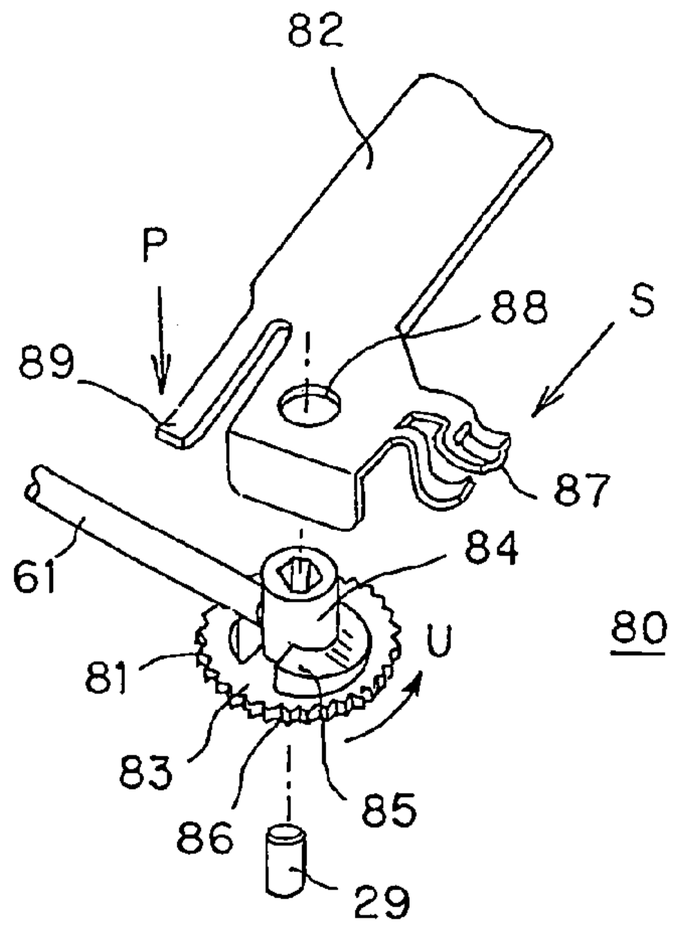
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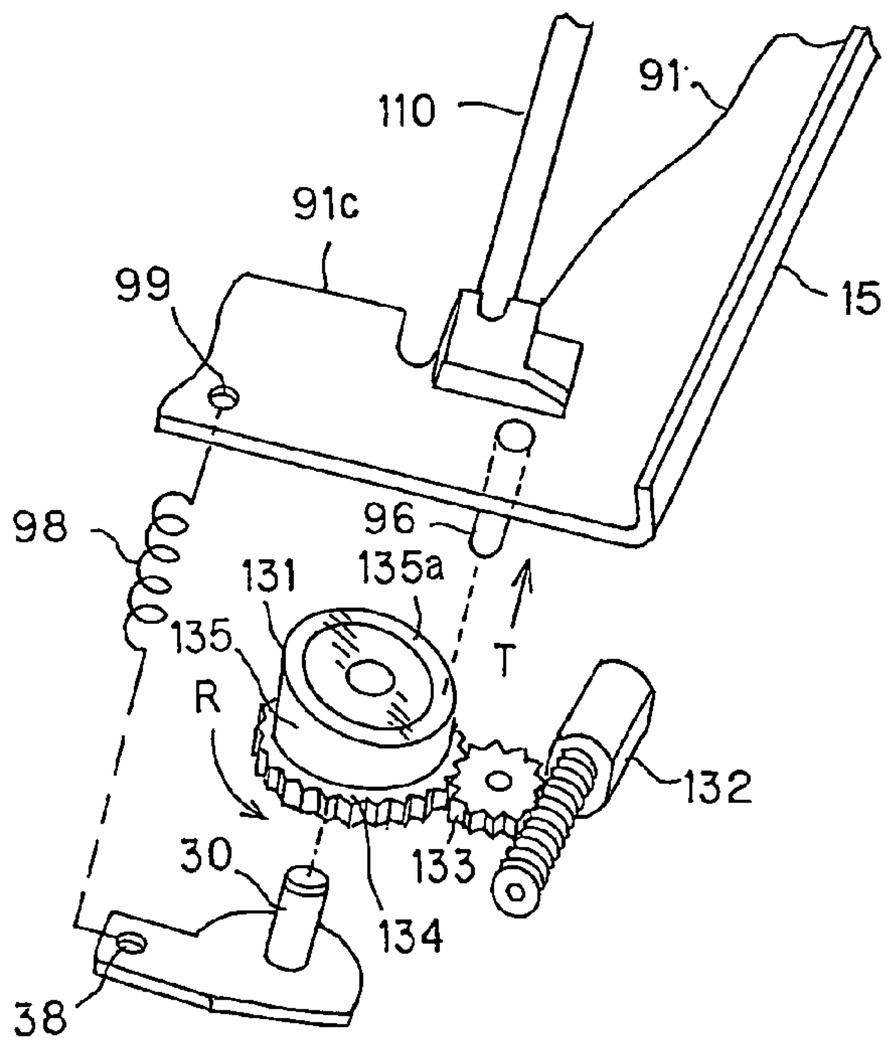
FIG.5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91c
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T
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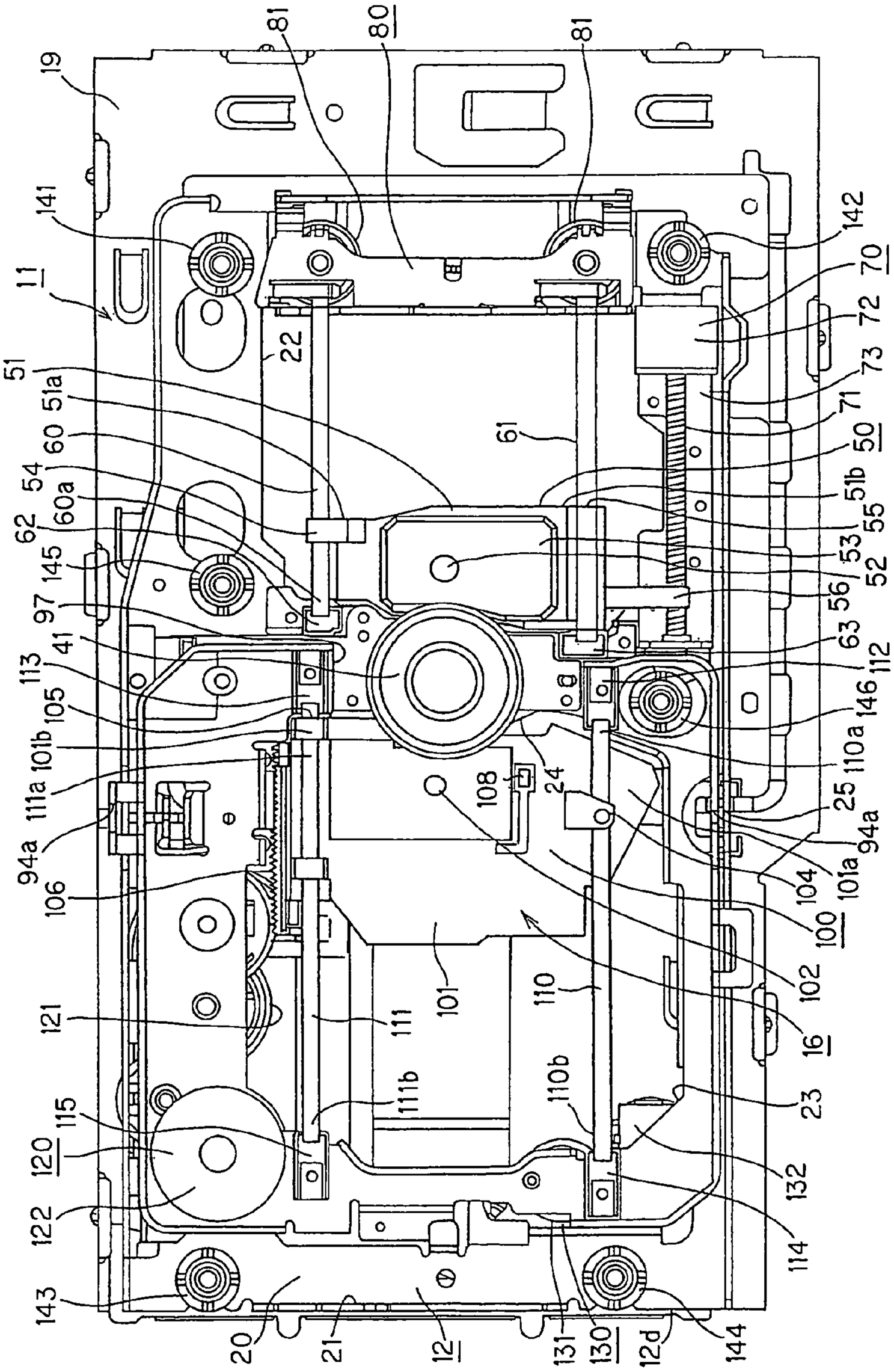
FIG.6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113
105
101b
111a
94a
106
121
115
120
122
143
20
21
12
131
130
12d
144
132
114
23
16
100
102
101
110
111
111b
110b
108
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94a
101a
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110a
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63
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53
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51b
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61
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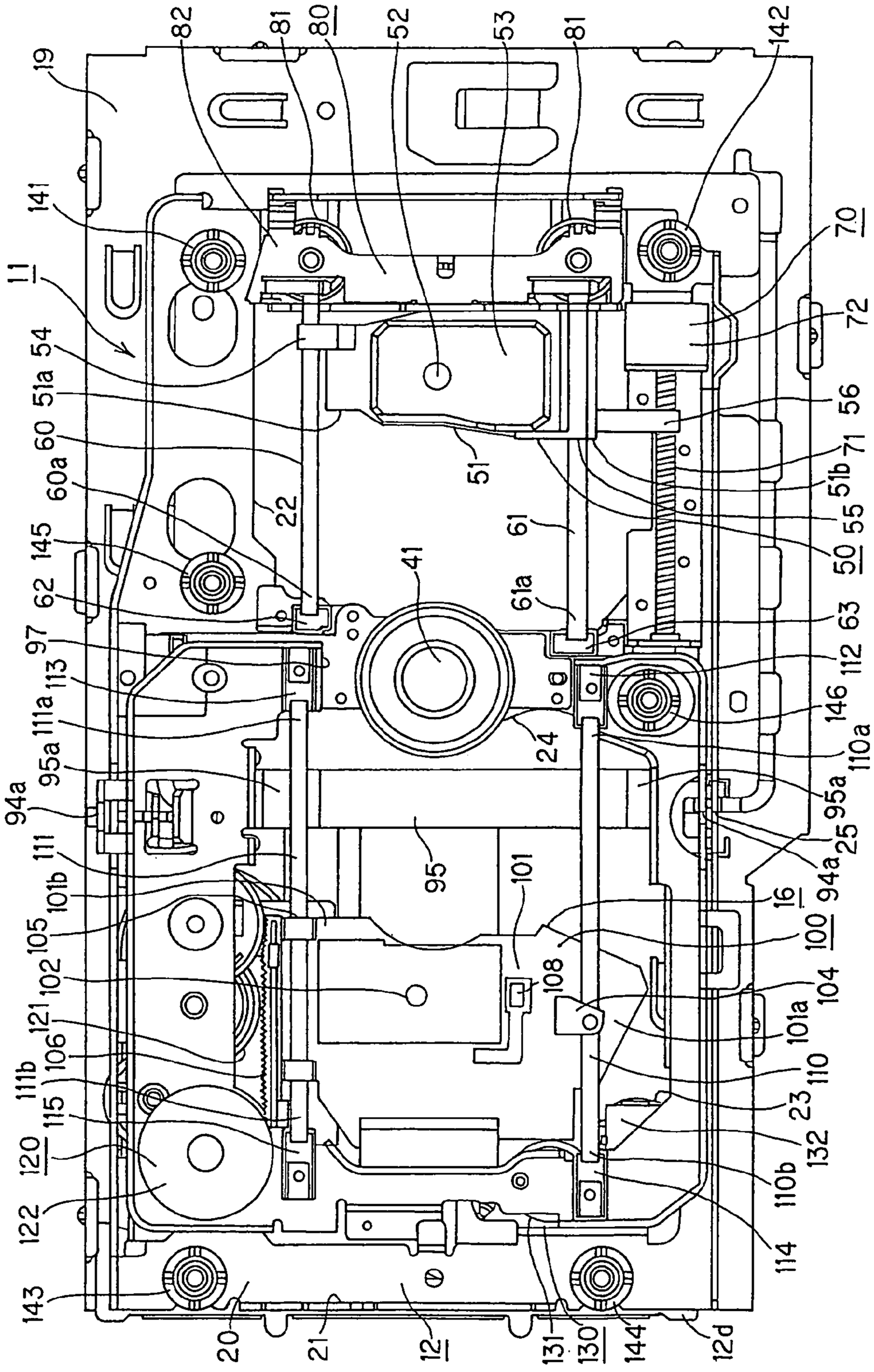
FIG.7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145
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62
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61a
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97
112
113
146
111a
24
110a
95a
94a
95a
25
111
94a
101b
95
101
16
105
100
102
108
104
121
101a
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144
12d

FIG.8

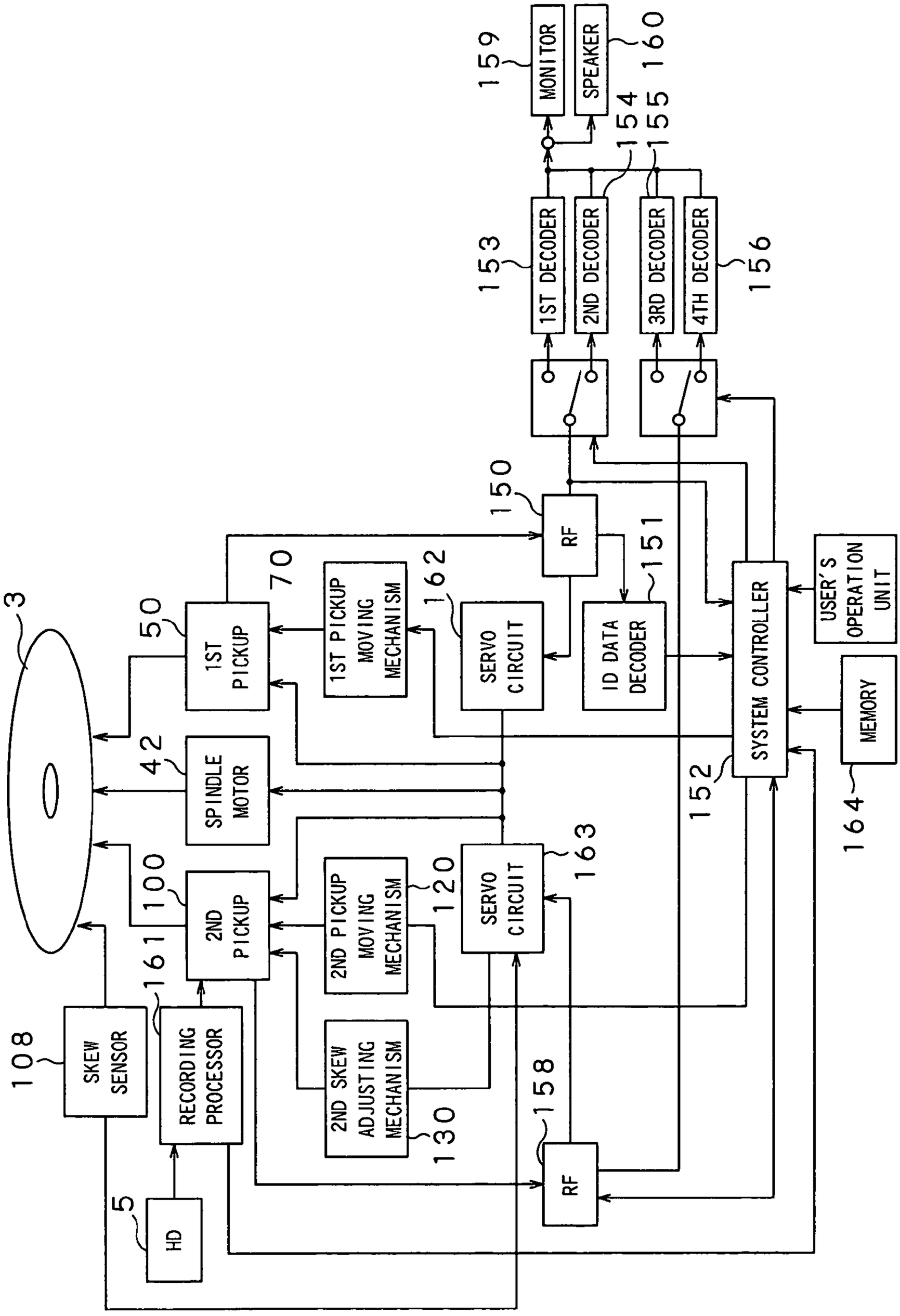
3
108
SKEW SENSOR
161
RECORDING PROCESSOR
5
HD
42
SPINDLE MOTOR
50
1ST PICKUP
70
1ST PICKUP MOVING MECHANISM
100
2ND PICKUP
120
2ND PICKUP MOVING MECHANISM
130
2ND SKEW ADJUSTING MECHANISM
150
RF
151
ID DATA DECODER
152
SYSTEM CONTROLLER
153
1ST DECODER
154
2ND DECODER
155
3RD DECODER
156
4TH DECODER
158
RF
159
MONITOR
160
SPEAKER
162
SERVO CIRCUIT
163
SERVO CIRCUIT
164
MEMORY
USER'S OPERATION UNIT

FIG.9

DISK DRIVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a disk drive including an optical pickup for playing an optical disk and an optical pickup for writing or reading information signals to or from the optical disk.

This application claims the priority of the Japanese Patent Application No. 2003-347673 filed on Oct. 6, 2003, the entirety of which is incorporated by reference herein.

2. Description of the Related Art

There has been proposed an optical disk drive including two optical pickups, one of which is to play a CD (compact disk), CD-R, CD-ROM or the like and the other of which is to play a DVD (digital versatile disk) (cf. the Japanese Patent Application Laid Open Nos. H09-282671 and H09-282672). The disk drive includes a device body and a sub chassis disposed inside the device body, and has disposed on the sub chassis a disk rotation drive to rotate each of various types of disk-shaped recording media while holding it, first pickup unit to read information signals or the like from a DVD, second pickup unit to play a CD, CD-R or CD-ROM and a skew adjusting mechanism to adjust an inclination of the first and second pickup units.

The sub chassis is formed generally rectangular, and has a damping member formed from rubber or the like provided near each corner thereof. The sub chassis is disposed inside the device body with the damping members laid between them, and thus it is isolated from vibration. Also, on the sub chassis, there are provided the disk rotation drive disposed nearly at the center, and the first and second pickup units disposed opposite to each other across the disk rotation drive or at a predetermined angle defined between them.

The disk rotation drive to hold each of various types of disk-shaped recording media rotatably includes a disk table on which the disk-shaped recording medium is place, and a spindle motor with a spindle shaft to which the disk table is fixed. The disk rotation drive rotates the disk-shaped recording medium set on the disk table at a constant linear velocity or angular velocity. The disk rotation drive is disposed nearly at the center of the sub chassis.

The first pickup unit to play a DVD is supported on a pair of guide shafts provided in parallel to the length of the sub chassis, and can freely be moved by a pickup moving mechanism radially of the DVD. Also, the first pickup unit includes a pickup having a semiconductor laser that emits a laser beam of 650 or 635 nm in wavelength, and a skew sensor.

The second pickup unit to play a CD, CD-R or CD-ROM is supported on the pair of guide shafts provided in parallel to the length of the sub chassis, and can freely be moved by a pickup moving mechanism radially of a CD or the like. Also, the second pickup unit includes a pickup having a semiconductor laser that emits a laser beam of 780 nm in wavelength.

In the disk drive, when a disk-shaped recording medium is held on the disk table, its type is detected and either the first or second pickup unit is selected which is suitable for the specifications of the recording medium. Then, the first or second pickup unit selected correspondingly to the type of the disk-shaped recording medium set on the disk table is activated to emit a laser beam having a predetermined wavelength for reading information signals from the recording medium. Also, an inclination of the reading laser beam is detected by the skew sensor provided on the first pickup unit with reference to a skew detection hole, and one of the guide shafts in pair is driven by the skew adjusting mechanism. Thus, each pickup in the first or second pickup unit supported on the pair of guide shafts has the inclination of an objective lens thereof adjusted for adjustment of a skew.

In such a disk drive, the pair of guide shafts is provided to extend over the sub chassis and the first and second pickup units supported on the pair of guide shafts are disposed on the same sub chassis, so that the first and second pickup units can have the height thereof defined accurately. Therefore, the disk drive can accurately position the disk-shaped recording medium without any troublesome positional adjustment of the first and second pickup units in relation to the disk-shaped recording medium.

In the above disk drive, however, either the first or second optical pickup unit is selected correspondingly to the type of a disk-shaped recording medium inserted in the device body, the pickup in the selected one of the optical pickup units is moved radially of the disk-shaped recording medium. At this time, the pickup in the other optical pickup unit not selected is positioned at the inner or outer radius of the disk-shaped recording medium. Therefore, if the pickup in the selected optical pickup unit moves to the outer or inner radius of the disk-shaped recording medium, the weight of the sub chassis will be imbalanced.

More specifically, the disk drive has the disk rotation drive provided generally at the center of the sub chassis and the first and second pickup units provided in positions opposite to each other across the disk rotation drive so that when each of the pickups in the first and second pickup units is in an initial position at the outer or inner radius of a disk-shaped recording medium, the center of gravity of the sub chassis will come to the disk rotation drive including the spindle motor which will be a source of vibration. However, when one of the optical pickup units, selected correspondingly to the type of a disk-shaped recording medium set in place, is moved, the weight balance of the sub chassis will be lost.

Thus, the center of gravity of the sub chassis will be off the spindle motor which is the source of vibration, vibration isolation will be lost, disk-shaped recording medium cannot be rotated stably, and no skew can be detected accurately.

Also, there have recently been prevailing disk drives capable of reading information signals from a disk-shaped recording medium such as a DVD and also writing information signals to the recording medium. Such a disk drive is required to have a capability of detecting and correcting an inclination of the optical axis of a laser beam in relation to the disk-shaped recording medium in which the recording track pitch is small, such as a DVD, with a higher accuracy than that in a disk drive which plays a CD or the like.

Also, the distance between an optical disk and skew sensor always varies since it depends upon the type of a disk-shaped recording medium such as CD, DVD or the like, state in which the disk-shaped recording medium is chucked to the disk table, warp of the disk-shaped recording medium and so forth. On this account, skew detection and adjustment are always done while the disk-shaped recording medium is being rotated, for an accurate skew detection of the skew sensor.

In the aforementioned disk drive, however, a pair of guide shafts is provided to extend on one sub chassis, a first pickup unit dedicated for CD and second pickup unit dedicated for DVD are supported on the guide shafts, respectively, and skew of these first and second pickup units is adjusted through adjustment of an inclination of the guide shaft. Thus, it is difficult to make an accurate, real-time skew adjustment while the disk-shaped recording medium is being rotated.

Also, there have recently been prevailing disk drives capable of reading information signals from a disk-shaped

recording medium such as a DVD and also writing information signals to the recording medium. Such a disk drive is required to have a capability of accurately detecting the type of a disk-shaped recording medium set in place in order to define a write or read format, and writing or reading information signals to or from the disk-shaped recording medium in a format corresponding to the detected type of the disk-shaped recording medium.

Also, there have recently been prevailing disk drives capable of reading information signals from a disk-shaped recording medium such as a DVD and also writing information signals to the recording medium. Such a disk drive is designed to write or read information signals to or from a disk-shaped recording medium whose recording track pitch is small, such as a DVD, by having a laser beam in a predetermined format corresponding to the type of the inserted disk-shaped recording medium track a recording track on the latter while accurately controlling tracking and focusing in relation to the disk-shaped recording medium.

Conventionally, to verify whether information signals have normally been written to such a high recording-density disk-shaped recording medium, an optical pickup unit used for writing information signals is used to read information signals. Therefore, since the information signals are read after writing the information signals, the verification cannot be done rapidly.

Also, in the conventional disk drive, since a disk-shaped recording medium is to be carried along the length of a sub chassis, so it has to be carried over a long distance from a disk slot in a device body to a disk table. Also, the disk transport mechanism to carry a disk-shaped recording medium along the length of the sub chassis is considerably large. Further, because of the long carrying distance, it will take a considerably long time to inset or eject the disk-shaped recording medium.

Also, in case the disk-shaped recording medium is to be carried on a disk tray, the disk tray should have formed therein openings through which first and second optical pickup units can be exposed to the signal recording surface of the disk recording medium within a range between the inner and outer radii of the latter. The openings have to be formed opposite to each other across the center of a disk mount. Therefore, the rigidity of the disk tray cannot be assured and also the disk tray should be produced by a complicated process.

Also, in the conventional disk drive, a damping member to isolate a sub chassis from vibration is provided near each corner of the sub chassis, and a spindle motor as a source of vibration is disposed nearly at the center of the sub chassis. Therefore, the damping member is so separated from the source of vibration that it cannot effectively absorb vibration from the spindle motor. Also, the damping member is provided near each corner of the sub chassis. As the first or second optical pickup unit is moved to the inner radius of a disk-shaped recording medium and thus approaches the spindle motor as the source of vibration, the damping member will be separated from the first or second optical pickup unit. Thus, write or read of information signals will possibly be adversely affected by the vibration of the spindle motor.

OBJECT AND SUMMARY OF THE INVENTION

It is therefore an object of the present invention to overcome the above-mentioned drawbacks of the related art by providing a disc drive including two optical pickup units and capable of making weight balancing of the whole device while one of the optical pickup devices is being driven.

The above object can be attained by providing a disk drive including according to the present invention:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the latter;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to write and/or read information signals to and/from a first disk-shaped recording medium set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit radially of the first disk-shaped recording medium;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write and/or read information signals to and/or from a second disk-shaped recording medium set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit radially of the second disk-shaped recording medium; and

a controlling means for making weight balancing of the base chassis by detecting a distance over which one of the first and second optical pickup units has been moved and moving the other optical pickup unit radially of the first or second disk-shaped recording medium synchronously with the one optical pickup unit.

In the above disk drive according to the present invention, since one of the first and second optical pickup units disposed opposite to each other on the base chassis is moved toward the inner or outer radius of the first or second disk-shaped recording medium while the other optical pickup unit is moved toward the inner or outer radius of the first or second disk-shaped recording medium synchronously with the movement of the one optical pickup unit, the movement of the other optical pickup will counterbalance a change in weight balance of the base chassis, caused by the movement of the one optical pickup unit. Therefore, even if the first or second optical pickup unit has been moved to any position between the inner and outer radii of the first or second disk-shaped recording medium, the center of gravity of the base chassis will not be off the disk rotation drive as a source of vibration, whereby the first or second disk-shaped recording medium can be kept stably rotated without any axial deflection. Also, because the first or second disk-shaped recording medium is rotated stably, the first or second optical pickup unit can write or read content data positively.

It is another object of the present invention to provide a disk drive including two pickup units corresponding to different types of disk-shaped recording media and capable of making an accurate, real-time skew adjustment.

The above object can be attained by providing a disk drive including according to the present invention:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the latter;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to only read information signals recorded in a first disk-shaped recording medium set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit radially of the first disk-shaped recording medium;

a first skew adjusting means for adjusting a skew of the first optical pickup unit correspondingly to an inclination of the first optical pickup unit;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write and/or read information signals to

and/or from a second disk-shaped recording medium set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit radially of the second disk-shaped recording medium;

a skew detecting means for detecting an inclination of the optical axis of light emitted from the second optical pickup unit in relation to the second disk-shaped recording medium; and

a second skew adjusting means for adjusting a skew of the second optical pickup unit writing or reading information signals to or from the second disk-shaped recording medium by adjusting an inclination of the second optical pickup unit correspondingly to the optical axis inclination detected by the skew detecting means.

The above disk drive according to the present invention includes the first optical pickup unit to only read information signals from the first disk-shaped recording medium, second optical pickup unit to write and/or read information signals to and/or from the second disk-shaped recording medium, and the first and second skew adjusting mechanisms to make a skew adjustment of the first and second optical pickup units, and can thus make an accurate, real-time skew adjustment of the second optical pickup unit during reading or writing information signals from or to the second disk-shaped recording medium. Therefore, the two optical pickup units and skew adjusting mechanisms can selectively be used correspondingly to the type of a disk-shaped recording medium inserted in the device to write or read content data at an appropriate skew angle.

It is another object of the present invention to provide a disk drive including two optical pickup units corresponding to different types of disk-shaped recording medium and which writes or reads information signals, in which the type of a disk-shaped recording medium inserted in the device body can be detected with a high accuracy.

The above object can be attained by providing a disk drive including according to the present invention:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the latter;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to read information signals from a first disk-shaped recording medium set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit radially of the first disk-shaped recording medium;

a first skew adjusting means for adjusting a skew of the first optical pickup unit correspondingly to an inclination of the optical axis in relation to the disk-shaped recording medium;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write and/or read information signals to and/or from a second disk-shaped recording medium set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit radially of the second disk-shaped recording medium;

a skew detecting means for detecting an inclination of the optical axis of light emitted from the second optical pickup unit in relation to the second disk-shaped recording medium;

a second skew adjusting means for adjusting a skew by adjusting an inclination of the second optical pickup unit correspondingly to an inclination of the optical axis, detected by the skew detecting means; and

a detecting means for detecting the type of a disk-shaped recording medium inserted by the second optical pickup unit into the device body.

In the above disk drive, the second optical pickup unit is used to write or read information signals to or from various types of disk-shaped recording media, and the skew detecting means and skew adjusting means accurately correct an inclination of the optical axis of a laser beam projected onto the signal recording surface having a very small physical format including a track pitch, pit, etc. Therefore, using the second optical pickup unit to detect the type of a disk-shaped recording medium, it is possible to distinguish between disks through accurate detection of identification data recorded on the signal recording surface.

It is another object of the present invention to provide a disk drive including two optical pickup units corresponding to a plurality of types of disk-shaped recording medium and which writes or reads information signals, in which the type of a disk-shaped recording medium inserted in the device body can be detected by one of the optical pickup units that is used less frequently, thereby permitting to assure a longer service life of the entire device.

The above object can be attained by providing a disk drive including according to the present invention:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the latter;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to read information signals from a first disk-shaped recording medium set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit radially of the first disk-shaped recording medium;

a first skew adjusting means for adjusting a skew of the first optical pickup unit correspondingly to an inclination of the optical axis in relation to the disk-shaped recording medium;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write and/or read information signals to and/or from a second disk-shaped recording medium set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit radially of the second disk-shaped recording medium;

a skew detecting means for detecting an inclination of the optical axis of light emitted from the second optical pickup unit in relation to the second disk-shaped recording medium;

a second skew adjusting means for adjusting a skew by adjusting an inclination of the second optical pickup unit correspondingly to an inclination of the optical axis, detected by the skew detecting means; and

a detecting means for detecting the type of a disk-shaped recording medium inserted by the first optical pickup unit into the device body.

In the above disk drive, the first optical pickup unit is used to only read data from the disk-shaped recording medium and less frequently than the second optical pickup unit which is used to write and/or read data to and/or from the disk-shaped recording medium. Therefore, the first optical pickup unit is used to detect the type of a disk-shaped recording medium inserted in the device body, thereby permitting to reduce the load to the frequently used second optical pickup unit and thus assure a longer service life of the entire device.

It is another object of the present invention to provide a disk drive including two optical pickup units corresponding to a plurality of types of disk-shaped recording medium and which writes or reads information signals, in which it can be verified rapidly whether the information signals have successfully been written to a disk-shaped recording medium.

The above object can be attained by providing a disk drive including according to the present invention:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the latter;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to write and/or read information signals to and/or from a first disk-shaped recording medium set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit radially of the first disk-shaped recording medium;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write and/or read information signals to and/or from a second disk-shaped recording medium set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit radially of the second disk-shaped recording medium; and

a detecting means for detecting whether the first optical pickup unit has successfully written information signals to the disk-shaped recording medium while the second optical pickup unit is wiring the information signals to the disk-shaped recording medium.

In the above disk drive, there are provided the first and second optical pickup units, and it is possible to rapidly detect any write error and retry a write through simultaneous verification of whether the first and second optical pickup units have successfully written. Therefore, this disk drive can write data, and retry to write data, to a disk-shaped recording medium more rapidly than a disk drive including a single optical pickup unit and in which write error is detected by the optical pickup unit after completion of data write.

It is another object of the present invention to provide a disk drive in which the distance over which a disk-shaped recording medium is carried is so short as to rapidly insert or eject the disk-shaped recording medium.

The above object can be attained by providing a disk drive including according to the present invention:

a device body having formed at the front side thereof a disk slot through which a disk-shaped recording medium is inserted;

a base chassis formed generally rectangular and disposed inside the device body for the length thereof to be parallel to the front of the device body;

a disk rotation drive including a disk table disposed nearly at a longitudinal middle of the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the latter;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to write and/or read information signals to and/or from a first disk-shaped recording medium set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit from near the longitudinal middle of the base chassis to one end of the latter; and

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write and/or read information signals to and/or from a second disk-shaped recording medium set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit from near the longitudinal middle of the base chassis to the other end of the latter,

the disk-shaped recording medium being carried in a direction perpendicular to a moving direction of the first or second optical pickup unit.

In the above disk drive, the base chassis is disposed for the length thereof to be parallel to the front of the device body, and the disk-shaped recording medium inserted through the disk slot is carried in the direction perpendicular to the longitudinal direction of the base chassis in which the first and second optical pickup units are moved. Therefore, in the disk drive according to the present invention, the distance over which the disk-shaped recording medium is carried to the disk rotation drive is shorter than that in a conventional disk drive in which a disk-shaped recording medium is carried in the longitudinal direction of the base chassis in which the optical pickup unit is moved. Therefore, the disk-shaped recording medium can be loaded and unloaded more rapidly. Also, because of this reduced distance over which the disk-shaped recording medium is to be carried, the disk carrying means may be designed more compact.

It is another object of the present invention to provide a disk drive having two optical pickup units disposed opposite to each other across a spindle motor which will be a source of vibration, in which it is possible to effectively suppress the vibration from the spindle motor, thereby limiting the influence of the vibration on the write or read of information signals to or from a recording medium.

The above object can be attained by providing a disk drive including according to the present invention:

a base frame;

a base chassis formed generally rectangular and installed on the base frame;

a disk rotation drive including a disk table disposed nearly at a longitudinal middle of the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the latter;

a first optical pickup mechanism including a first optical pickup unit disposed at one longitudinal end of the base chassis to write and/or read information signals to and/or from a first disk-shaped recording medium set on the disk table, a pair of first guide shafts extending from near the longitudinal middle of the base chassis to one end of the latter to guide the first optical pickup unit in moving over the disk-shaped recording medium between the inner and outer radii of the latter, and a first pickup moving mechanism that moves the first optical pickup unit along the pair of first guide shafts; and

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write and/or read information signals to and/or from a second disk-shaped recording medium set on the disk table, a pair of second guide shafts extending from near the longitudinal middle of the base chassis to the other end of the latter to guide the second optical pickup unit in moving over the disk-shaped recording medium between the inner and outer radii of the latter, and a second pickup moving mechanism that moves the second optical pickup unit along the pair of second guide shafts,

the base chassis having a pair of first damping members at each outer side of the first and second guide shafts which guide the disk-shaped recording medium in moving between the inner and outer radii of the latter and also a pair of second guide shafts at the inner sides of the first and second guide shafts.

In the above disk drive, when the first and second optical pickup units are moved to the inner radius of the disk-shaped recording medium in which direction they are nearer to the spindle motor as a source of vibration, they are enclosed along with the vibration-source spindle motor with the first and second damping members, whereby it is possible to effectively prevent the optical pickup units from being influ-

enced by the vibration of the spindle motor. Also, when the first and second optical pickup units are moved to the outer radius of the disk-shaped recording medium in which direction they are away from the vibration-source spindle motor, they are enclosed with three damping members including a pair of first damping members and at least a second damping member. Thus, the optical pickup units can be prevented from being adversely affected by the vibration of the spindle motor.

These objects and other objects, features and advantages of the present invention will become more apparent from the following detailed description of the preferred embodiments of the present invention when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of the disk drive according to the present invention;

FIG. **2** is a perspective view of the write/read unit;

FIG. **3** is a perspective view of the write/read mechanism included in the write/read unit;

FIG. **4** is an exploded perspective view of the write/read mechanism;

FIG. **5** is an exploded perspective view of the first skew adjustment mechanism;

FIG. **6** is an exploded perspective view of the second skew adjustment mechanism;

FIG. **7** is a plan view of the write/read mechanism with both the first and second optical pickup units having been moved to the inner radius of a disk-shaped recording medium;

FIG. **8** is a plan view of the write/read mechanism with both the first and second optical pickup units having been moved to the outer radius of the disk-shaped recording medium; and

FIG. **9** is a block diagram of the disk drive.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in detail concerning the embodiments thereof with reference to the accompanying drawings.

The disk drive according to the present invention, generally indicated with a reference **1**, is to write and/or read information signals to and/or from a plurality of disk-shaped recording media such as a CD, DVD, etc. As shown in FIG. **1**, it includes a device body **2** having provided therein a write/read unit **4** that holds any one of a plurality of types of disk-shaped recording media **3** such as a CD, DVD, etc. rotatably and writes and/or read content data to and/or from the disk-shaped recording medium **3**, and a hard disk drive **5** that holds an operating system (OS), browsing software, electronic mail program, communications protocol, various application programs, audio data, movie data, etc.

In the disk drive **1**, the read-only disk-shaped recording medium **3** such as a CD, DVD or the like is set in the write/read unit **4**, and content data such as recorded game software, application program, video data, audio data, etc. are read from the disk-shaped recording medium **3** and supplied as output signals to a monitor device such as a television set. Also, in the disk drive **1**, a writable disk-shaped recording medium **3** such as CD-R, DR-RW, DVD-R, DVD-RAM, DVD+RW, DVD-RW or the like is set in the write/read unit **4**, and content data such as an application program, video data, audio data, etc. stored in a memory such as the hard disk drive **5** are written to the disk-shaped recording medium **3** set in the write/read unit **4**. The content data can thus be stored in the disk-shaped recording medium **3**.

Also, the disk drive **1** includes two optical pickup mechanisms as will be described later. The first one of the optical pickup mechanisms is used to only read a first disk-shaped recording medium **3***a* having various content data recorded therein in a first format, and the second optical pickup mechanism is used to read a second disk-shaped recording medium **3***b* having various content data recorded therein in a second format and write various content data in the second format to the second disk-shaped recording medium **3***b*.

In the disk drive **1**, the write/read unit **4** is disposed at the front side **2***a* of the device body **2**, and the hard disk drive **5**, power unit (not shown), etc. are disposed at the rear side **2***a*. At the front side **2***a* of the device body **2**, there is formed a disk slot **7** through which the disk-shaped recording medium **3** to be loaded into the write/read unit **4** is inserted and ejected. The disk-shaped recording medium **3** inserted from the disk slot **7** is carried by a carrying mechanism (not shown) to the rear side **2***b* of the device body **2**, and loaded into the write/read unit **4**. After completion of write or read of content data to or from the disk-shaped recording medium **3**, the latter is carried by the carrying mechanism to the front side **2***a* of the device body **2** and ejected through the disk slot **7**.

Note that the carrying mechanism to carry the disk-shaped recording medium **3** into or out of the device body **2** through the disk slot **7** is provided near the disk slot **7** and it includes a pair of conveying rollers extending toward the surface of the disk-shaped recording medium **3** or toward both sides of the disk-shaped recording medium **3**, a supporting member extending from the front side **2***a* of the device body **2** to the rear side **2***b* to support the disk-shaped recording medium **3** at the outermost-peripheral top and bottom or edge and guide the disk-shaped recording medium **3** in moving inside the device body **2**, and a push-out member to push out the disk-shaped recording medium **3** to the disk slot **7** at the time of ejection. When the disk-shaped recording medium **3** inserted in the disk slot **7** is detected, the conveying rollers are rotated while holding the disk-shaped recording medium **3** between them at the top and bottom sides or side edge to carry the disk-shaped recording medium **3** to the rear side **2***b* of the device body **2**. Also, for ejection of the disk-shaped recording medium **3**, the push-out member pushes out the disk-shaped recording medium **3** to the front side **2***a* and are rotated while holding the disk-shaped recording medium **3** between them, thereby ejecting the disk-shaped recording medium **3** to outside the disk slot **7**.

Next, the write/read unit **4** to write and/or read content data to and/or from the disk-shaped recording medium **3** will be explained with reference to FIGS. **2** and **3**. FIGS. **2** and **3** are perspective views, respectively, from the rear side **2***b* of the device body **2**, of the write/read unit **4**.

As shown in FIG. **2**, the write/read unit **4** includes a base frame **10**, as a unit housing, composed of a pair of upper and lower frames, and a write/read mechanism **11** housed in the base frame **10**. As shown in FIG. **3**, the write/read mechanism **11** includes a base chassis **12** on which various components are provided, a disk rotation drive **13** provided on the base chassis **12** to rotate the disk-shaped recording medium **3**, a first optical pickup mechanism **14** provided on the base chassis **11** to read content data from the disk-shaped recording medium **3**, a sub chassis **15** provided on the base chassis **12**, and a second optical pickup mechanism **16** provided on the sub chassis **15** to write and/or read content data to and/or from the disk-shaped recording medium **3**.

The base frame **10** is formed from the upper and lower frames **18** and **19** to provide a housing for the write/read unit **4** and house the write/read mechanism **11** in it. The upper frame **18** of the base frame **10** has formed therein an opening

through which a disk table of the disk rotation drive **13**, which will be described in detail later, is projected from an upper side **18***a* of the upper frame **18**. In the base frame **10**, the disk-shaped recording medium **3** loaded on the disk table projected out from the upper side **18***a* of the upper frame **18** is held rotatably on the upper side **18***a* of the upper frame **18**. Also, the lower frame **19** of the base frame **10** has disposed thereon the base chassis **12** of the write/read mechanism **11** and a circuit board **17** on which a drive circuit of the write/read mechanism **11** and the like are formed.

As shown in FIGS. **3** and **4**, the base chassis **12** of the write/read mechanism **11**, housed in the base frame **10**, is formed generally rectangular, and includes a mount surface **20** on which the first optical pickup mechanism **14**, sub chassis **15** and second optical pickup mechanism **16** are mounted, and an upright peripheral wall **21** along the periphery of the base chassis **12**, not including some portions near the corner of the mount surface **20**. The mount surface **20** has formed therein first and second openings **22** and **23** in which the pickup bases of the first and second optical pickup mechanisms **14** and **16** are moved. These openings **22** and **23** are formed longitudinally of the mount surface **20**, and there is formed nearly at the longitudinal middle of the mount surface **20** a mount **24** on which the spindle motor of the disk rotation drive **13** is disposed.

Note that in the following description, the long-side direction of the base chassis **12** will be referred to as "right-left direction" and the short-side direction of the base chassis **12**, perpendicular to the long-side direction be referred to as "front-rear direction". As shown in FIGS. **3** and **4**, the first optical pickup mechanism **14** is disposed in the first opening **22** formed in the base chassis **12** at the right side of the latter, and the sub chassis **15** and second optical pickup mechanism **16** are disposed in the second opening **23** formed in the base chassis **12** at the left side of the latter. FIGS. **3** and **4** are perspective views, respectively, from the rear side **12***b*, of the base chassis **12**. As shown in FIG. **1**, the base chassis **12** is disposed to have the front side **12***a* thereof directed toward the front side **2***a* of the device body **2**.

At the right side **12***c* of the base chassis **12**, there is formed a pair of first mounts **29** on which there is installed a first skew adjusting mechanism **80** to make a skew adjustment of the first optical pickup mechanism **14**. The first mounts **29** are provided separately from each other in the front-rear direction. Also, the base chassis **12** has damper openings **31** and **32** formed near both corners of the right side **12***c* of the mount surface **20**. In these openings **31** and **32**, there are installed damping members which will be described in detail later. The damper openings **31** and **32** are located in a position corresponding to the outer radius of the disk-shaped recording medium **3** mounted on the disk rotation drive **13**, and there are installed in the damper openings **31** and **32** outer dampers **141** and **142** which prevent the first optical pickup unit **50** moved to the outer radius of the disk-shaped recording medium **3** from being vibrated.

At the left side **12***d* of the base chassis **12**, there is formed a second mount **30** to which there is installed a second skew adjusting mechanism **130** to make a skew adjustment of the second optical pickup mechanism **16** by adjusting the angle at which the sub chassis **15** as will be described in detail later. The second mount **30** is formed in a position nearer to the rear side **12***b* of the base chassis **12**. Near the second mount **30**, there is formed an engagement hole **38** in which a forcing member such as a helical torsion spring, engaged at one end thereof on the sub chassis **15**, is engaged at the other end. The sub chassis **15** is always forced toward the base chassis **12** under the action of the forcing member. Also, the base chassis **12** has damper openings **33** and **34** formed therein near both the corners at the left side **12***d* of the mount surface **20**. In these damper openings **33** and **34**, there are installed damping members which will be described in detail later. The damper openings **33** and **34** are also located in positions corresponding to the outer radius of the disk-shaped recording medium **3** placed on the disk rotation drive **13**, and have installed thereto outer dampers **143** and **144** which prevent vibration of a second optical pickup unit **100** having been moved to the outer radius of the disk-shaped recording medium **3**.

The mount **24** formed nearly at the longitudinal middle of the base chassis **12** extends between the first and second openings from the front side **12***a* to rear side **12***b* in the front-rear direction of the base chassis **12**. The mount **24** has damper openings **35** and **36** formed in the end portions thereof at the front side **12***a* and rear side **12***b* of the base chassis **12**. In these damper openings **35** and **36**, there are installed damping members which will be described in detail later. The damper openings **35** and **36** are located at the inner radius of the disk-shaped recording medium **3** placed on the disk rotation drive **13**, and have installed therein inner dampers **145** and **146** to prevent vibration of the first and second optical pickup units **50** and **100** having been moved to the inner radius. Also, the mount **24** has formed nearly at the middle thereof a circular mounting opening **37** through which there is to be mounted a spindle motor **42** which will be described in detail later.

Next, there will be explained the disk rotation drive **13** installed on the mount **24** of the base chassis **12**. The disk rotation drive **13** holds and rotates a disk-shaped recording medium **3** inserted into the disk drive **1**.

The disk rotation drive **13** includes a disk table **41** on which a disk-shaped recording medium **3** is to be mounted, a spindle motor **42** to spin the disk table **41**, and a mount base plate **43** having the spindle motor **42** mounted thereon and which is installed to the mount **24**. The disk table **41** has formed thereon a disk-shaped disk mount **41***a* and a centering portion **41***b* which enters the central hole of the disk-shaped recording medium **3** to center the latter. The spindle motor **42** to spin the disk table **41** is connected at a spindle shaft end (not shown) thereof to the centering portion **41***b* of the disk table **41**. Thus, it is rotatably coupled to the disk table **41**. The mount base plate **43** on which the spindle motor **42** is mounted is formed from a rigid plate, and has formed thereon a wiring pattern which transmits control signals for controlling the operation of the spindle motor **41**. The mount base plate **43** is disposed nearly at the right-left (longitudinal) middle of the base chassis **12** and screwed to the mount **24**. It should be noted that the spindle motor **42** has the lower end thereof inserted in the mounting opening **37** formed in the mount **24**.

When the disk-shaped recording medium **3** is chucked to the disk table **41**, the disk rotation drive **13** will put the spindle motor **42** into revolution and rotate the disk table **41** and disk-shaped recording medium **3** on the latter as the spindle motor **42** spins.

Next, the first optical pickup mechanism **14** provided at the right side **12***c* of the base chassis **12** will be explained. The first optical pickup mechanism **14** is used to only read a first disk-shaped recording medium **3***a* having various content data recorded therein in a first format.

The first optical pickup mechanism **14** includes the first optical pickup unit **50** to read content data from the first disk-shaped recording medium **3***a*, a pair of guide shafts **60** and **61** to guide the first optical pickup unit **50** in moving, and a pickup moving mechanism **70** that moves the first optical pickup unit **50** along the guide shafts **60** and **61**.

The first optical pickup unit **50** includes a rectangular pickup base **51** forming a pickup proper. On the pickup base **51**, there are installed at least a light source (not shown) such as a semiconductor laser, an objective lens **52** to focus a light beam emitted from the light source onto the signal recording layer of the disk-shaped recording medium **3**, a photodetector (not shown) to detect a return light from the signal recording surface of the disk-shaped recording medium **3**, and a drive system to move the objective lens **52** over the disk-shaped recording medium **3** in the focusing and tracking directions. Also, to the pickup base **51** fixed is a cover member **53** having formed therein an opening through which the objective lens **52** is exposed to outside. Also, the first optical pickup mechanism **14** has formed at one longitudinal end **51***a* of the pickup base **51** an engagement piece **54** which is engaged on the guide shaft **60** as will be described in detail later, and has formed at the other longitudinal end **51***b* thereof an insertion hole **55** in which the guide shaft **61** is inserted as will be described in detail later. It should be noted that the pickup base **51** has a flexible wiring board on which there are formed a drive circuit to control the drive system for the objective lens **52** and the like.

Also, at the other end **51***b* of the pickup base **51**, there is formed an engagement member **56** which is engaged on a lead screw **71** of the pickup moving mechanism **70**, by which the pickup base **51** is moved radially of the disk-shaped recording medium **3**. The engagement member **56** has formed thereon an engagement projection **57** which is engaged in threads formed on the lead screw **71**. As the lead screw **71** is rotated, the engagement projection **57** is moved in the direction in which the threads are formed, whereby the pickup base **51** is moved along the guide shafts **60** and **61**.

The guide shafts **60** and **61** to guide the pickup base **51** in moving are disposed in parallel to each other along the length of the base chassis **12** and over the first opening **22**. The guide shafts **60** and **61** are supported at one ends **60***a* and **61***a* thereof on bearing members **62** and **63**, respectively, provided in the front-rear direction on the mount **24** formed nearly at the longitudinal middle of the base chassis **12**, and at the other ends **60***b* and **61***b* in bearing recesses **63***a* and **63***b*, respectively, in a bearing wall **63** formed on the mount surface **20** at the right side **12***c* of the base chassis **12**. Also, the guide shafts **60** and **61** are engaged at the other ends **60***b* and **61***b*, respectively, on a first skew adjusting mechanism **80** which will be described in detail later.

The above guide shaft **60** is engaged on the engagement piece **54** provided at the one end **51***a* of the pickup base **51**, and the guide shaft **61** is inserted into the insertion hole **55** formed in the other end **51***b* of the pickup base **51**, to thereby guide the pickup base **51** in moving radially of the disk-shaped recording medium **3**.

The pickup moving mechanism **70** that moves the pickup base **51** along the guide shafts **60** and **61** on which the engagement member **56** of the pickup base **51** is engaged includes the lead screw **71** engaged on the engagement member **56** of the pickup base **51**, and a screw motor **72** to rotate the lead screw **71**. The lead screw **71** is supported at both free and base ends thereof on a bearing plate **73**. Also, the lead screw **71** and screw motor **72** are introduced into the first opening **22** and fixed at the rear side **12***b* of the base chassis **12** with the bearing plate **73** being screwed to the base chassis **12**.

The engagement projection **57** formed on the engagement member **56** of the pickup base **51** is engaged in the threads formed on the body of the lead screw **71**. The pickup moving mechanism **70** feeds the engagement member **56** in the direction in which the threads are formed by appropriately rotating the lead screw **71** in forward or reverse, to thereby move the pickup base **51** to the inner or outer radius of the disk-shaped recording medium **3**.

Next, the first skew adjusting mechanism **80** to make a skew adjustment of the first optical pickup unit **50** will be explained. The first skew adjusting mechanism **80** is installed to the first mounts **29** formed separately from each other in the front-rear direction at the right side **12***c* of the mount surface **20** and correspondingly to the pair of guide shafts **60** and **61**. As shown in FIG. **5**, the first skew adjusting mechanism **80** includes lifting cams **81** having other ends **60***b* and **61***b* of the guide shafts **60** and **61** mounted on a slope thereof. As the lifting cams **81** are rotated, the other ends **60***b* and **61***b* are slid up or down on the slope. The first skew adjusting mechanism **80** includes also a control plate **82** to press the other ends **60***b* and **61***b* to the slope and control the rotation of the lifting cams **81**.

As shown in FIG. **5**, the lifting cams **81** has formed thereon a generally disk-shaped rotating portion **83**, an upright shaft portion **84** provided at the center of the rotating portion **83**, and a slope portion **85** formed to enclose the base end of the shaft portion **84**. The disk-like rotating portion **83** has formed along the perimeter thereof engagement grooves **86** in which a detent projection **87** of the control plate **82** is engaged. It should be noted that FIG. **5** shows the lifting cams **81** and control plate **82**, provided to move up or down the guide shaft **61** provided at the rear side **12***b* of the base chassis **12**.

With the detent projections **87** of the control plate **82** being engaged in the engagement grooves **86**, the lifting cams **81** are restricted from being rotated. The upright shaft **84** provided at the center of the rotating portion **83** is a hollow cylinder in which the first mount **29** formed at the right side **12***c* of the base chassis **12** is rotatably inserted from below. Therefore, the lifting cams **81** are rotated about the first mount **29** in the direction of arrow U or in a direction opposite to the arrow-U direction as in FIG. **5**. Also, the shaft **84** is open at the top thereof in the form of a polygon, and rotated with a skew adjusting jig (not shown) being engaged in the polygonal opening. The slope portion **85** formed to enclose the base end of the upright shaft **84** rises from a portion of the rotary portion **83** and gradually descends along the perimeter of the upright shaft **84**. It is rotated along with the rotating portion **83**. Also, the control plate **82** presses the other ends **60***b* and **61***b* of the guide shafts **60** and **61** to the corresponding slope portions **85** as will be described in detail later. Therefore, when the rotating portion **83** of each lifting cams **81** is rotated as the shaft **84** is turned with the skew adjusting jig, each of the other ends **60***b* and **61***b* of the guide shafts **60** and **61** and the corresponding slope portion **85** will relatively slide on each other, and thus the inclination of each of the guide shafts **60** and **61** will be adjusted. More specifically, when the rotating portion **83** of the lifting cam **81** is rotated in the direction of arrow U in FIG. **5**, the other end **61***b* of the guide shaft **61** is elevated. When the rotating portion **83** is rotated in the direction opposite to the U-arrow direction in FIG. **5**, the other end **61***b* of the guide shaft **61** is lowered. Thus, the inclination of the guide shaft **61** is adjusted. The guide shaft **60** is also elevated and lowered similarly to that of the guide shaft **61**.

The control plate **82** is formed generally rectangular to press the other ends **60***b* and **61***b* of the guide shafts **60** and **61** to the slope portions of the lifting cams **81**. It includes the detent projections **87** provided at the opposite longitudinal ends thereof to restrict the lifting cams **81** from being rotated, openings **88** through which the shaft **84** is exposed at the top

thereof to outside, and pressing pieces **89** to press the guide shafts **60** and **61** to the corresponding slope portions **85** of the lifting cams **81**, respectively.

The detent projection **87** is forced in the direction of arrow S as in FIG. **5** and engaged in the engagement groove **86** formed in the rotating portion **83** of the lifting cam **81** to restrict the lifting cam from being rotated. When the lifting cam **81** is rotated by the skew adjusting jig, the detent projection **87** will sequentially be engaged in the engagement grooves **86** while being elastically displaced in the direction opposite to the direction of arrow S in FIG. **5**.

The top of the shaft **84** of the lifting cam **81** is exposed to outside through the opening **88** and thus the skew adjusting jig is engaged on the shaft **84** through the opening **88**, whereby the lifting cam **81** is rotated.

The pressing pieces **89** are forced in the direction of arrow P in FIG. **5** to press the other ends **60***b* and **61***b* of the guide shafts **60** and **61** to the slope portion **85** of the lifting cam **81**. Thus the pressing pieces **89** have the guide shafts **60** and **61** and the slope portion **85** slide relatively on each other as the lifting cam **81** is rotated. Thus, the guide shafts **60** and **61** will have the other ends **60***b* and **61***b* thereof elevated correspondingly to the rotation of the lifting cam **81**.

The aforementioned first skew adjusting mechanism **80** makes a skew adjustment of the first optical pickup unit **50** during production, or at shipment, of the disk drive **1**. More specifically, when the disk table **41** having mounted thereon the first disk-shaped recording medium **3***a* having data as a sample recorded in the first format is put into rotation, a laser beam emitted from a light emitting element installed on the first optical pickup unit **50** is reflected at the signal recording surface of the first disk-shaped recording medium **3***a* and detected by a photodetector provided to detect a return light from the disk-shaped recording medium. The laser beam detected by the photodetector is supplied to a differential amplifier in which it will undergo differential amplification to provide a skew error signal whose level will vary correspondingly to an inclination of the optical axis of the laser beam. Then, in the first skew adjusting mechanism **80**, the skew adjusting jig is engaged on the shaft **84** of the lifting cam **81** to rotate the rotating portion **83** of the lifting cam **81** in the direction of arrow U or in the direction opposite to the U-arrow direction in FIG. **5** for the skew error signal to have a minimum value.

As the lifting cam **81** is rotated, any or both of the guide shafts **60** and **61** slides on the slope portion **85** of the lifting cam **81** to have the other ends **60***b* and **61***b* thereof elevated or lowered, whereby the inclination of the guide shafts **60** and **61** will be adjusted. Thus, the first optical pickup unit **50** supported on the guide shafts **60** and **61** will have a skew adjusted.

Note here that the first optical pickup unit **50** is provided to only read the first disk-shaped recording medium **3***a* having various content data recorded therein in the first format and not to write or read any data to or from the second disk-shaped recording medium **3***b* having data recorded therein in the second format as will be described in detail later. Therefore, the first optical pickup unit **50** is not required for any high-accuracy skew adjustment which is to be done for writing data to the disk-shaped recording medium **3**. Namely, it will not undergo any skew adjustment after a coarse skew adjustment is done by the first skew adjusting mechanism **80** during production, or at shipment, of the disk drive **1**.

Next, there will be explained the sub chassis **15** disposed over the second opening **23** formed at the left side of the base chassis **12** and having the second optical pickup mechanism **16** provided thereon. The sub chassis **15** supports the second optical pickup mechanism **16** and has the inclination thereof adjusted by the second skew adjusting mechanism **130** provided on the base chassis **12** to make a high-accuracy skew adjustment of the second optical pickup mechanism **16**.

As shown in FIG. **4**, the sub chassis **15** is formed generally rectangular. It includes a main surface **90** and a pickup opening **91** formed in the main surface **90** correspondingly to the moving range of the second optical pickup unit **16**.

The main surface **90** has a damper opening **92** formed therein correspondingly to the damper opening **36** formed in the peripheral corner portion at the rear side **12***b*. The damper member is exposed upward through the damper opening **92**. Also, the sub chassis **15** has a peripheral wall **93** formed along the periphery thereof except for the front-rear-directional nearly middle portions of the main surface **90**. At the front and rear sides **93***a* and **93***b* of the peripheral wall **93**, there are formed rotation supports **94** as the center of rotation of the sub chassis **15** whose inclination is adjusted by the second skew adjusting mechanism **130** as will be described in detail later. Each of the rotation supports **94** has an insertion hole **94***a* formed therein. The rotation supports **94** are rotatably coupled to the peripheral walls **21**, respectively, of the base chassis **12** with the insertion holes **94***a* being aligned with coupling holes **25** formed in the peripheral wall **21** at the front and rear sides **12***a* and **12***b* of the base chassis **12** and with a screw or the like being inserted in each pair of the insertion holes **94***a* and coupling holes **25**.

The above pickup opening **91** is an area in which the second optical pickup mechanism **16** is moved radially of the disk-shaped recording medium **3** as will be described in detail later. It is open (as indicated with a reference **97**) at the right edge **91***a* thereof. When the sub chassis **15** is placed on the base chassis **12**, the disk table **41** and spindle motor **42** of the disk rotation drive **13** will be positioned in the open end **97**. Also, a coupling member **95** is provided over the pickup opening **91** in a position near the right edge **91***a* of the latter to extend in the front-rear direction. Further, the pickup opening **91** has formed near the left edge **91***c* thereof a motor opening **91***b* in which there is disposed a spindle motor **122** of a second pickup moving mechanism **120** that moves the second optical pickup mechanism **16**. The coupling member **95** extends over the open end **97** of the pickup opening **91** to assure an increased rigidity of the sub chassis **15** and a sufficient rigidity of the whole base chassis **12**. The coupling member **95** has base ends **95***a* and a main portion **95***b* extending in the front-rear direction between the base ends **95***a*. Since the base ends **95***a* are inclined toward the base chassis **12**, so the main portion **95***b* extends below the second opening **23** in the base chassis **12**, that is, it extends not on the moving orbit of the second optical pickup mechanism **16**.

Also, the sub chassis **15** has provided thereon near the left edge **91***c* of the pickup opening **91***a* skew adjusting shaft **96** projecting from the base chassis **12** downward and whose inclination is to be adjusted by the second skew adjusting mechanism **130**. The skew adjusting shaft **96** slides at the lower end thereof on a skew adjusting cam **131** of the second skew adjusting mechanism **130** so as to be elevated or lowered, thereby adjusting the inclination of the sub chassis **15**. Also, near the skew adjusting shaft **96**, there is formed an engagement hole **99** in which there is hooked one end of a forcing member **98** such as a helical torsion spring hooked at the other end thereof in the engagement hole **38** in the base chassis **12**. Thus, the sub chassis **15** is always forced by the forcing member **98** toward the base chassis **12**.

Next, the second optical pickup mechanism **16** disposed on the sub chassis **15** will be explained. The second optical pickup mechanism **16** is used to write or read content data to

or from the second disk-shaped recording medium **3***b* having various content data recorded therein in the second format.

The second optical pickup mechanism **16** includes the second optical pickup unit **100** to write or read content data to or from the second disk-shaped recording medium **3***b*, a pair of guide shafts **110** and **111** to guide the second optical pickup unit **100** in moving, and a pickup moving mechanism **120** that moves the second optical pickup unit **100** along the guide shafts **110** and **111**.

The second optical pickup unit **100** includes a generally rectangular pickup base **101** as a pickup proper. On the pickup base **101**, there are disposed at least a light source (not shown) such as a semiconductor laser, an objective lens **102** to converge and focus a light beam emitted from the light source onto the signal recording surface of the disk-shaped recording medium **3**, a photodetector (not shown) to detect a return light from the signal recording surface of the disk-shaped recording medium **3**, a drive system to move the objective lens **102** in the focusing and tracking directions over the disk-shaped recording medium **3**, and a skew sensor **108** to detect a skew of the second optical pickup unit **100**. Also, the second optical pickup mechanism **16** has formed at one longitudinal end **101***a* of the pickup base **101** an engagement piece **104** which is engaged on the guide shaft **110** as will be described in detail later, and has also formed at the other longitudinal end **101***b* an insertion hole **105** in which the guide shaft **111** is inserted as will be described in detail later. It should be noted that the pickup base **101** has mounted thereon a flexible wiring board on which a drive circuit to control the drive system for the objective lens **102**, and the like.

Also, the pickup base **101** has provided at the other end **101***b* thereof a rack member **106** which is in mesh with a gear mechanism **121** of the pickup moving mechanism **120** that moves the pickup base **101** radially of the disk-shaped recording medium **3**. When the gear mechanism **121** is rotated, the pickup base **101** is moved along with the rack member **106** along the guide shafts **110** and **111**.

The guide shafts **110** and **111** to guide the pickup base **101** in moving are disposed in parallel to each other longitudinally of the base chassis **12** to extend over the second opening **23** in the base chassis **12** and pickup opening **91** in the sub chassis **15**. Also, the guide shafts **110** and **111** are supported at the one ends **110***a* and **111***a* thereof on bearing members **112** and **113** provided separately from each other in the front-rear direction on the main surface **90** in positions near the open end **97** of the pickup opening **91** and at the other ends **110***b* and **111***b* thereof on bearing members **114** and **115** formed on the main surface **90** at the left edge **91***c* of the pickup opening **91**.

The above guide shaft **110** is engaged on the engagement piece **104** provided at the one end **101***a* of the pickup base **101**, and the guide shaft **111** is inserted in the insertion hole **105** formed in the other end **101***b* of the pickup base **101**, to thereby guide the pickup base **101** in moving radially of the disk-shaped recording medium **3**.

The pickup moving mechanism **120** includes the gear mechanism **121** which is to be in mesh with the rack member **106** of the pickup base **101**, and a feed motor **122** that rotates the gear mechanism **121**. With the rack member **106** being in mesh with the gear mechanism **121**, the pickup moving mechanism **120** moves the pickup base **101** along the guide shafts **110** and **111**. The gear mechanism **121** and feed motor **122** are screwed to the mount surface **20** of the base chassis **12** or main surface **90** of the sub chassis **15**, and thus fixed to the front side **12***a* of the second opening **23** in the base chassis **12**.

As mentioned above, the rack member **106** formed integrally on the pickup base **101** is in mesh with the gear mechanism **121**. With the gear mechanism **121** being appropriately rotated by the feed motor **122** in forward or reverse to move the rack member **106** in the right-left direction, the pickup moving mechanism **120** moves the pickup base **101** to the inner or outer radius of the disk-shaped recording medium **3**.

Next, there will be explained the second skew adjusting mechanism **130** that makes a skew adjustment of the second optical pickup unit **100**. The second skew adjusting mechanism **130** is fixed to the second mount **30** provided at the left side **12***d* of the base chassis **12** in a position nearer to the rear side **12***b*. As shown in FIG. **6**, the second skew adjusting mechanism **130** includes the skew adjusting cam **131** that adjusts an inclination of the sub chassis **15** by sliding the free end of the skew adjusting shaft **96** of the sub chassis **15** relatively on a slope portion of the skew adjusting cam **131**, a skew adjusting motor **132** to rotate the skew adjusting cam **131**, and a gear mechanism **133** to convey the rotation of the skew adjusting motor **132** to the skew adjusting cam **131**.

As shown in FIG. **6**, the skew adjusting cam **131** includes a generally disk-shaped rotating portion **134**, and an obliquely-truncated conical portion **135** formed upright along the periphery the rotating portion **134**. The generally disk-shaped rotating portion **134** has formed on the periphery thereof an engagement portion **136** on which the gear mechanism **133** is engaged. Therefore, a rotation of the skew adjusting motor **132** is conveyed to the rotating portion **134** via the gear mechanism **133** engaged on the engagement portion **136** to rotate the rotating portion **134**. Also, the rotating portion **134** has formed at the center thereof an insertion hole (not shown) in which the second mount **30** of the base chassis **12** is inserted, and thus it is supported rotatably on the base chassis **12**.

Also, the obliquely-truncated conical portion **135** is formed along the periphery of the rotating portion **134** as above, and has an inclined surface **135***a* formed on the top thereof. The skew adjusting shaft **96** provided on the bottom of the sub chassis **15** to project downward toward the base chassis **12** will abut the inclined surface **135***a*. This inclined surface **135***a* gradually descends toward the periphery of the rotating portion **134**. As the rotating portion **134** is rotated, the obliquely-truncated conical portion **135** is rotated along with the rotating portion **134**. Also, as the sub chassis **15** is forced by the forcing member **98** toward the base chassis **12**, the skew adjusting shaft **96** is pressed at the free end thereof to the inclined surface **135***a* of the obliquely-truncated conical portion **135**. Therefore, as the rotating portion **134** of the skew adjusting cam **131** is rotated by the skew adjusting motor **132** via the gear mechanism **133**, the skew adjusting shaft **96** slides relatively on the inclined surface **135***a* to elevate or lower the sub chassis **15**. More specifically, the rotating portion **134** of the skew adjusting cam **131** is rotated in the direction of arrow R in FIG. **6**, the skew adjusting shaft **96** slides up on the inclined surface **135***a* to tilt the sub chassis **15** in the direction of arrow T in FIG. **6**. When the rotating portion **134** is rotated in a direction opposite to the direction of arrow R in FIG. **6**, the skew adjusting shaft **96** slides down on the inclined surface **135***a* to tilt the sub chassis **15** in a direction opposite to the direction of arrow T in FIG. **6**.

The aforementioned second skew adjusting mechanism **130** makes a skew adjustment of the second optical pickup unit **100** which is writing or reading content data to or from the disk-shaped recording medium **3***b* inserted in the disk drive **1**. More particularly, infrared light emitted from the skew sensor **108** installed in the second optical pickup unit **100** is reflected at the signal reflecting surface of the second disk-shaped recording medium **3***b* and the reflected light is detected by the skew sensor **108**. The skew sensor **108** supplies the differential amplifier with an output corresponding

to an inclination of the signal recording surface of the second disk-shaped recording medium **3***b*. The output from the skew sensor **108** undergoes differential amplification in the differential amplifier to provide a skew error signal whose level varies depending upon the inclination of the laser beam. The skew adjusting motor **132** is driven by a servo circuit **163** for the skew error signal to have a minimum value, and the skew adjusting cam **131** is rotated by means of the gear mechanism **133** in the direction of arrow R or in a direction opposite to the direction of arrow R as in FIG. **6**.

As the skew adjusting cam **131** is rotated, the skew adjusting shaft **96** is sled up or down on the inclined surface **135***a* of the obliquely-truncated conical portion **135**. Thus, an inclination, in relation to the base chassis **12**, of the sub chassis **15** having the skew adjusting shaft **96** projecting downward is adjusted, and thus a skew of the second optical pickup unit **100** of the second optical pickup mechanism **16** disposed on the sub chassis **15** is adjusted.

Note here that the second optical pickup unit **100** is intended to write or read content data to or from the second disk-shaped recording medium **3***b* having various content data recorded therein in the second format as mentioned above. Also, the physical format including the track pitch, pit size, etc. on the signal recording surface of a DVD included in the second disk-shaped recording media **3***b* is smaller than that in a CD, whereby the allowance for the optical-axis inclination of the laser beam projected onto the signal recording surface is strictly limited. Further, if the optical axis of a light beam emitted from the second optical pickup unit **100** is not perpendicular but oblique to the signal recording surface of the second disk-shaped recording medium **3***b* to which content data is going to be written, an aberration will take place so that the light means will form a spot, not circular but elliptic, on the signal recording surface. In this case, no correct data recording is possible. On this account, the second optical pickup unit **100** is designed so that an inclination of the optical axis of a laser beam can be real-time detected with a high accuracy during write to or read from the second disk-shaped recording medium **3***b*, and any skew of the second optical pickup unit **100** can be adjusted by the skew adjusting mechanism **130** with a higher accuracy.

Also, the second skew adjusting mechanism **130** makes a skew adjustment of the second optical pickup unit **100** mounted on the sub chassis **15** by adjusting an inclination of the sub chassis **15**. As mentioned above, the second optical pickup unit **100** will have a skew thereof real-time adjusted while writing to or reading from the second disk-shaped recording medium **3***b*. If the guide shafts **110** and **111** are directly driven as in the first optical pickup unit **50**, the bearing members **112** to **115** will be so abraded due to frequent sliding contact with the guide shafts **110** and **111** that it will possibly be difficult to assure any stable skew adjustment. Also, if a mechanically strong material is used to form the guide shafts **110** and **111** and bearing members **112** to **115** in order to prevent them from being damaged, it will lead to a larger size and weight of the optical pickup mechanism. Further, if the skew adjusting means is assembled to the pickup base **101** of the second optical pickup unit **100** in order to make a skew adjustment, the second optical pickup unit **100** will be heavier and hence cannot have the skew thereof adjusted stably.

On the other hand, in the disk drive **1** according to the present invention, the sub chassis **15** is supported on the upright peripheral wall **21** to be rotatable about the rotation support **94** and the inclination of the sub chassis **15** is adjusted with the rotation support **94** being taken as a fulcrum. Therefore, also in case a real-time skew adjustment is done by the second skew adjusting mechanism **130**, the sub chassis **15**, guide shafts **110** and **111** and bearing members **112** to **115** will not be damaged due to any frequent adjustment of the sub chassis inclination and a stable skew adjustment can be done without any increased load to the second optical pickup unit **100**.

As shown in FIG. **7**, the write/read mechanism **11** of the disk drive **1** constructed as above has installed on the base chassis **12** the disk rotation drive **13**, first optical pickup mechanism **14** and the sub chassis **15** on which the second optical pickup mechanism **16** is installed. Thus, the first optical pickup unit **50** disposed at the right side of the base chassis **12**, and second optical pickup unit **100** disposed on the sub chassis **15** provided at the left side of the base chassis **12**, are supported on the pair of guide shafts **60** and **61** and pair of guide shafts **110** and **111**, respectively, to be symmetrical in the right-left direction.

Namely, the engagement piece **54** at the one end **51***a* of the pickup base **51** is engaged on the guide shaft **60**, and the guide shaft **61** is inserted in the insertion hole **55** at the other end **51***b*. Thus, the first optical pickup unit **50** is supported on the guide shafts **60** and **61** at three points thereof including the engagement piece **54** and opposite ends of the insertion hole **55**. On the other hand, the engagement piece **104** formed at the one end **101***a* of the pickup base **101** is engaged on the guide shaft **110**, and the guide shafts **111** is inserted in the insertion hole **105** formed in the other end **101***b*, for the second optical pickup unit **100** to be symmetrical with the first optical pickup unit **50**. Thus, the second optical pickup unit **100** is supported on the guide shafts **110** and **111** at three points thereof including the engagement piece **104** and opposite ends of the insertion hole **105**.

Thus, the write/read mechanism **11** including the first and second optical pickup units **50** and **100** has the weight thereof balanced taking, as the center of balancing, the disk rotation drive **13** disposed nearly at the center of the base chassis **12**. Therefore, since the weight of the write/read unit **4** is thus balanced, the disk drive **1** can stably write or read content data to or from the disk-shaped recording medium **3**.

Also, the base chassis **12** of the write/read mechanism **11** has the damper openings **31** to **36** formed near both corners of the right and left sides **12***c* and **12***d* at the front-rear-directional ends of the mount **24**, and the outer dampers **141** to **144** and inner dampers **145** and **146**, such as rubber bushes or the like, installed in the respective damper openings **31** to **36**, as shown in FIG. **7**.

Of the above dampers, the outer ones **141** and **142** and inner ones **145** and **146** are disposed to surround the moving range of the first optical pickup unit **50**. More particularly, the first optical pickup unit **50** is moved between the inner and outer radii of the disk-shaped recording medium **3** placed on the disk rotation drive **13** and it will be surrounded by the outer dampers **141** and **142** and inner dampers **145** and **146** in any place within the above moving range, as shown in FIGS. **7** and **8**. When the first optical pickup unit **50** is moved to the inner radius toward the spindle motor **42** as a source of vibration, it will be surrounded along with the spindle motor **42** as the vibration source by the outer dampers **141** and **142** and inner dampers **145** and **146**. Thus, these dampers will damp the vibration of the spindle motor **42** more effectively. Also, when the first optical pickup unit **50** is moved to the outer radius away from the spindle motor **42** as the vibration source, it will be surrounded by at least three of the pair of outer dampers **141** and **142** and the inner damper **145** or **146**, so that the influence of the vibration of the spindle motor **42** can be suppressed.

Similarly, the outer dampers **143** and **144** and inner dampers **145** and **146** are disposed to surround the moving range of the second optical pickup unit **100**. More specifically, the second optical pickup unit **100** is moved between the inner and outer radii of the disk-shaped recording medium **3** placed on the disk rotation drive **13** and it will be surrounded by the outer dampers **143** and **144** and inner dampers **145** and **146** in any place within the above moving range, as shown in FIGS. **7** and **8**. When the second optical pickup unit **100** is moved to the inner radius toward the spindle motor **42** as a source of vibration, it will be surrounded along with the spindle motor **42** as the vibration source by the outer dampers **143** and **144** and inner dampers **145** and **146**. Thus, these dampers will damp the vibration of the spindle motor **42** more effectively. Also, when the second optical pickup unit **100** is moved to the outer radius away from the spindle motor **42** as the vibration source, it will be surrounded by at least three of the pair of outer dampers **143** and **144** and the inner damper **145** or **146**, so that the influence of the vibration of the spindle motor **42** can be suppressed.

As above, the first and second optical pickup units **50** and **100** have their moving ranges surrounded by the pair of outer dampers **141** and **142** or **143** and **144** provided in positions corresponding to the outer radius of the disk-shaped recording medium **3** as well as by the pair of inner dampers **145** and **146** provided in positions corresponding to the inner radius of the disk-shaped recording medium **3**. Therefore, even if the optical pickup unit is moved to any place between the inner and outer radii of the disk-shaped recording medium **3**, it is possible to prevent write or read of content data to or from the disk-shaped recording medium from being influenced by the vibration of the spindle motor **42** as the vibration source.

Also, when the first or second optical pickup unit **50** or **100** is moved to the inner radius of the disk-shaped recording medium, it will be surrounded along with the spindle motor **42** as the source of vibration by the four dampers including the pair of inner dampers **145** and **146** and outer dampers **141** and **142** or **143** and **144**, whereby it can effectively be prevented from being influenced by the vibration.

Also, when the first or second optical pickup unit **50** or **100** is moved to the outer radius of the disk-shaped recording medium, it will be surrounded by at least three dampers including the pair of outer dampers **141** and **142** or **143** and **144** and inner dampers **145** or **146**, whereby it can positively be isolated from the vibration of the spindle motor **42**.

The disk drive **1** constructed as above functions as will be described below. Before the disk-shaped recording medium **3** is introduced into the device body **2** of the disk drive **1**, both the first and second optical pickup units **50** and **100** of the write/read mechanism **11** are at the inner radius near the disk rotation drive **13** and are waiting for introduction of the disk-shaped recording medium **3**.

When the disk-shaped recording medium **3** is introduced from the disk slot **7** formed in the front side **2***a* of the device body **2**, it is carried by the disk carrying mechanism which will not be described in detail herein to the rear side **2***b* of the device body **2** and loaded onto the disk table **41** of the write/read unit **4** as shown in FIG. **1**.

Then, in the disk drive **1** according to the present invention, the write/read unit **4** is disposed with the length thereof being parallel to the front side **2***a* of the device body **2** and the disk-shaped recording medium **3** introduced from the disk slot **7** is carried in the direction of arrow F or in a direction opposite to the direction of arrow F in FIG. **1**, namely, in the front-rear direction of the base chassis **12** of the write/read unit **4**. That is, the disk-shaped recording medium **3** is carried in the front-rear direction perpendicular to the length of the base chassis **12** and in which the first and second optical pickup units **50** and **100** are moved. Therefore, compared with a disk drive in which a disk-shaped recording medium is carried longitudinally of the base chassis, namely, in a direction in which the optical pickup unit is moved, the disk drive **1** according to the present invention has only to carry the disk-shaped recording medium **3** over a shorter distance to the disk table **41**, and thus can load and unload the disk-shaped recording medium more rapidly. Also, because of the shorter distance over which the disk-shaped recording medium **3** is carried, the disk carrying mechanism can be designed more compact.

When the disk-shaped recording medium **3** is carried by the disk carrying mechanism onto the disk table **41**, the type of the disk-shaped recording medium **3** is detected. The disk drive **1** will write or read content data to or from the disk-shaped recording medium **3** in a format corresponding to the detected disk type.

The type of the disk-shaped recording medium **3** is detected by the first optical pickup unit **50**. When the disk-shaped recording medium **3** is rotated by the disk rotation drive **13**, the first optical pickup unit **50** projects a laser beam emitted from the light emitting element to the signal recording surface of the disk-shaped recording medium **3** and detects a return light from the signal recording surface by the photodetector. The laser light detected by the photodetector is supplied to an identification data decoder **151** via an RF circuit **150**, and identification data recorded at a predetermined address on the disk-shaped recording medium **3** is detected (as shown in FIG. **9**). Then, a system controller **152** identifies the type of the disk-shaped recording medium **3** mounted on the disk table on the basis of the detected identification data.

Then, the system controller **152** will select the first or second optical pickup unit **50** or **100** correspondingly to the identified type of the disk-shaped recording medium **3**. More specifically, when the first disk-shaped recording medium **3***a* having content data recorded therein in the first format is mounted on the disk table, the first optical pickup unit **50** will be selected. On the other hand, in case the second disk-shaped recording medium **3***b* having content data recorded therein in the second format is mounted on the disk table, the second optical pickup unit **100** will be selected. Also, the system controller **152** selects one of four decoders **153** to **156** which decode the recorded content data correspondingly to the detected type of the disk-shaped recording medium **3**. For example, in case the first disk-shaped recording medium **3***a* having the content data recorded therein in the first format is detected, the system controller **152** will select either the first or second decoder **153** or **154**. Either the first or second decoder **153** or **154** is selected correspondingly to a difference between new and old versions of the reading format. Also, in case the second disk-shaped recording medium **3***b* having the content data recorded therein in the second format is detected, the system controller **152** will select either the third or fourth decoder. Any of the third and fourth decoders, such as CD write/read decoder and DVD write/read decoder, for example, is selected correspondingly to differences in physical format including the track pitch, pit size, etc. of the disk-shaped recording medium **3** and data format including the modulation method etc. between the first and second disk-shaped recording media. It should be noted that the number of the decoders to be used is appropriately increased or decreased correspondingly to the type of the writing or reading format of the disk-shaped recording medium **3**.

In the disk drive **1** according to the present invention, the type of the disk-shaped recording medium **3** mounted on the

disk table **41** is detected by the first optical pickup unit **50** as above. As mentioned above, the first optical pickup unit **50** is used to only read data from the first disk-shaped recording medium **3***a* having content data recorded therein in the first format. Namely, the first optical pickup unit **50** is used less frequently than the second optical pickup unit **100** used to write or read data to or from the second disk-shaped recording medium **3***b* to which content data is to be recorded in the second format. Therefore, using the first optical pickup unit **50** to detect the type of a disk-shaped recording medium **3** set on the disk table **41**, it is possible to reduce the load to the frequently used second optical pickup unit **100** and thus assure a longer service life of the second optical pickup unit **100**.

According to the present invention, the disk drive **1** may also be designed to use the second optical disk unit **100** for detection of the type of the disk-shaped recording medium **3** mounted on the disk table. As above, the second optical pickup unit **100** is used to write or read data to or from the second disk-shaped recording medium **3***b* to which content data is to be recorded in the second format, and in the second optical pickup unit **100**, a skew is real-time detected and adjusted and an inclination of the optical axis of the laser beam projected onto the signal recording surface is corrected with a high accuracy in order to focus the laser beam perpendicularly to the signal recording surface in which the track pitch, pit and the like included in the physical format are small.

Therefore, using the second optical pickup unit **100** to detect the type of the disk-shaped recording medium **3** mounted on the disk table **41**, it is possible to detect a disk accurately without any error in disk type detection.

When the type of a disk-shaped recording medium **3** is detected, an optical pickup unit corresponding to the detected disk type is selected and the decoders corresponding to the detected disk type is selected, content data will be written to, or read from, the disk-shaped recording medium **3** correspondingly to a user's operation.

Concerning the first optical pickup mechanism **14**, it is assumed here that the first disk-shaped recording medium **3***a* having content data recorded therein in the first format is set on the disk table. In this case, as the lead screw **71** of the pickup moving mechanism **70** is rotated by the screw motor **72** driven with a control signal supplied from the system controller **152**, the engagement member **56** being in mesh with the lead screw **71** is moved in the direction in which the threads of the lead screw **71** are formed. Thus, the pickup base **51** of the first optical pickup unit **50** will be moved between the inner and outer radii of the first disk-shaped recording medium **3***a*, namely, in the direction in which the guide shafts **60** and **61** extend.

Concerning the second optical pickup mechanism **16**, it is assumed here that the second disk-shaped recording medium **3***b* having content data recorded therein in the second format is set on the disk table. In this case, as the gear mechanism **121** of the pickup moving mechanism **120** is rotated by the feed motor **122** driven with a control signal supplied from the system controller **152**, the rack member **106** being in mesh with the gear mechanism **121** is moved. Then, the second optical pickup unit **100** connected to the rack member **106** is moved along with the rack member **106** and thus the pickup base **101** is moved between the inner and outer radii of the second disk-shaped recording medium **3***b*, that is, in the direction in which the guide shafts **110** and **111** extend.

Then, in the first or second optical pickup unit **50** or **100** selected correspondingly to the type of the disk-shaped recording medium **3**, a laser beam emitted from the light emitting element and having a predetermined wavelength is guided to the objective lens **52** or **102** via a beam splitter. The objective lens **52** or **102** projects the laser beam onto the signal recording surface of the disk-shaped recording medium **3** and focuses it on a recording track where pits are recorded. Then, the laser beam has the intensity thereof modulated based on the pit state in the recording track and reflected by a reflective layer of the disk-shaped recording medium **3** for being incident back upon the objective lens **52** or **102**. The objective lens **52** or **102** allows the return light to pass by for incidence upon the photodetector through the beam splitter. In the disk drive **1**, a read output from the photodetector, corresponding to the pit state, is sent to the first to fourth decoders **153** to **156** pre-selected by the RF circuit **150** or **158**. After decoded by modulation or otherwise processing in the decoders, the read output is supplied to a monitor **159** and speaker **160** connected to the device body **2** to reproduce the content data.

Also, when writing content data to the disk-shaped recording medium **3**, the second optical pickup unit **100** is supplied with a string of to-be-recorded data supplied from the hard disk drive **5** and converted by a recording processor **161** into a predetermined format, and writes the data string to the disk-shaped recording medium **3**. The recording processor **161** includes an encoding circuit and modulation circuit. The supplied string of to-be-recorded data has an error correction code added thereto by the encoding circuit, and undergoes 8-14 modulation or 8-16 modulation in the modulation circuit.

While the first or second optical pickup unit **50** or **100** is writing or reading data, a servo circuit **162** or **163** drives the spindle motor **42** until the disk-shaped recording medium **3** arrives at a target velocity of rotation.

The servo circuit **162** or **163** drives a biaxial actuator on the basis of a focus error signal (FE signal) supplied from the RF amplifier **150** or **158** to make focusing servo control for displacing the focal position of the light beam in relation to the disk-shaped recording medium **3**. More specifically, the servo circuit **162** or **163** forms a negative feedback servo loop in which the FE signal will be zero, to thereby drive the biaxial actuator. Also, the servo circuit **162** or **163** drives the biaxial actuator on the basis of a tracking error signal (TE signal) supplied from the RF amplifier **150** or **158** to make tracking servo control for moving the position on which the light beam is focused in a direction perpendicular to the recording track of the disk-shaped recording medium **3**. More particularly, the servo circuit **162** or **163** forms a negative feedback servo loop in which the TE signal will be zero, to thereby drive the biaxial actuator.

Note here that since the first optical pickup unit **50** has been skew-adjusted during production or at shipment, it can read content data from the first disk-shaped recording medium **3***a* without any trouble. On the other hand, since the second optical pickup unit **100** has to always correct an inclination of the optical axis in relation to the signal recording surface of the second disk-shaped recording medium **3***b* to write or read content data to or from the second disk-shaped recording medium **3***b*, so it makes a real-time skew adjustment during data write or read.

More particularly, in the second optical pickup unit **100**, infrared light emitted from the skew sensor **108** is reflected at the signal recording surface of the second disk-shaped recording medium **3***b* and this reflected infrared light is detected by the skew sensor **108**. The skew sensor **108** produces a skew error signal by making differential amplification of the detected infrared light and supplies it to the servo circuit **163**. The servo circuit **163** drives the skew adjusting

motor **132** of the second skew adjusting mechanism **130** for the skew error signal to have a minimum value.

As above, the disk drive **1** according to the present invention includes the first and second optical pickup units **50** and **100**, and the first and second skew adjusting mechanisms **80** and **130** which make a skew adjustment of the first and second optical pickup units **50** and **100**, respectively. The first optical pickup unit **50** has been roughly skew-adjusted during production, or at shipment, of the disk drive **1**. The second optical pickup unit **100** is real-time skew-adjusted accurately during write to, or read from, the disk-shaped recording medium **3** having content data recorded therein in the second format. Therefore, the two pickup mechanisms and skew adjusting mechanisms are selectively used correspondingly to the type of the disk-shaped recording medium **3** mounted on the disk table, to thereby permit write or read of content data at an appropriate skew angle.

Also, in the disk drive **1** according to the present invention, when one of the optical pickup units is moved between the inner and outer radii of the disk-shaped recording medium **3**, the other optical pickup unit is also moved synchronously with the one optical pickup unit, so that the center of the base chassis **12** is always controlled for balance with the spindle motor **42**.

Specifically, in the disk drive **1**, the system controller **152** detects the distances over which the first and second optical pickup units **50** and **100** have been moved, and controls the pickup moving mechanisms **70** and **120** to move, correspondingly to the detected distance over which the one optical pickup unit has been moved, the other optical pickup unit (see FIG. **9**).

More specifically, the system controller **152** is connected to a memory **164** in which there is recorded a table in which the weight of the first and second optical pickup units **50** and **100**, distance over which the second optical pickup unit **100** is moved for counterbalance of the base chassis **12** in response to the movement of the first optical pickup unit **50**, and distance over which the first optical pickup unit **50** is moved for counterbalance of the base chassis **12** in response to the movement of the second optical pickup unit **100**, are correlated with each other. When one of the first and second optical pickup units **50** and **100**, selected correspondingly to the type of the disk-shaped recording medium **3** mounted on the disk table **41**, is moved by the pickup moving mechanism **70** or **120** between the inner and outer radii of the disk-shaped recording medium **3**, the system controller **152** detects the distance over which the selected optical pickup unit has been moved, and controls the motor of the pickup moving mechanism **70** or **120** on the basis of the table recorded in the memory **164** to move the other optical pickup unit to the inner and outer radii of the disk-shaped recording medium **3**.

As above, one of the first and second optical pickup units **50** and **100** disposed opposite to the base chassis **12** is moved between the inner and outer radii of the disk-shaped recording medium **3** while the other optical pickup unit is moved between the inner and outer radii of the disk-shaped recording medium **3** synchronously with the one optical pickup unit, so that the movement of the other optical pickup unit will counterbalance a change in weight balance of the base chassis **12**, caused by the movement of the one optical pickup unit. Therefore, even if the first or second optical pickup unit **50** or **100** has been moved to any position between the inner and outer radii of the disk-shaped recording medium **3**, the center of gravity of the base chassis **12** will not be off the spindle motor **42** as the source of vibration and thus the disk-shaped recording medium **3** can be kept stably rotated without any axial deflection. Also, since the disk-shaped recording medium **3** is thus rotated stably, so the first or second optical pickup unit **50** or **100** can positively write or read content data.

As shown in FIGS. **7** and **8**, the engagement piece **54** at the one end **51***a* of the pickup base **51** is engaged on the guide shaft **60**, and the guide shaft **61** is inserted in the insertion hole **55** at the other end **51***b*. Thus, the first optical pickup unit **50** is supported on the guide shafts **60** and **61** at three points thereof including the engagement piece **54** and opposite ends of the insertion hole **55**. On the other hand, the engagement piece **104** formed at the one end **101***a* of the pickup base **101** is engaged on the guide shaft **110**, and the guide shafts **111** is inserted in the insertion hole **105** formed in the other end **101***b*, in such a manner that the second optical pickup unit **100** and first optical pickup unit **50** will be symmetrical with respect to the disk rotation drive **13**. Thus, the second optical pickup unit **100** is supported on the guide shafts **110** and **111** at three points thereof including the engagement piece **104** and opposite ends of the insertion hole **105**.

Further, the pickup moving mechanism **70** to move the first optical pickup unit **50** is disposed adjacent to the guide shaft **61** and at the rear side **12***b* of the base chassis **12**. On the other hand, the pickup moving mechanism **120** to move the second optical pickup unit **100** is disposed adjacent to the guide shaft **111** and at the front side **12***a* of the base chassis **12** to be symmetrical with the pickup moving mechanism **70** with respect to the disk rotation drive **13**.

Thus, because of the above arrangement of the first and second optical pickup units **50** and **100**, the weight balance of the write/read mechanism **11** is kept about the disk rotation drive **13** disposed nearly at the center of the base chassis **12**. Therefore, since the weight of the write/read unit **4** is thus balanced, so the disk drive **1** can make stable write to, or read from, the disk-shaped recording medium **3**.

Also, in the disk drive **1** according to the present invention, while the second optical pickup unit **100** is writing content data, the first optical pickup unit **50** verifies whether the second optical pickup unit **100** has successfully written the content data to the disk-shaped recording medium **3**.

Since the disk drive **1** includes the second optical pickup unit **100** which is writable and the first optical pickup unit **50** which only reads data and thus the second optical pickup unit **100** can write data while the first optical pickup unit **50** can read data, so it is possible to real-time verify whether content data has successfully been written. Therefore, in the disk drive **1**, if a disturbance such as a shock has caused data write to be unsuccessful, it is possible to suspend the writing operation, rapidly detect an address where the writing has been made, and resume the writing.

More specifically, while the second optical pickup unit **100** is writing content data, the first optical pickup unit **50** emits light beam and detects return light from the signal recording surface by the photodetector. The return light detected by the photodetector is supplied to the system controller **152** via the RF circuit **150**. The system controller **152** is supplied with data to be written to the disk-shaped recording medium **3** from the recording processor **161**. Then, the system controller **152** will compare the to-be-recorded data supplied from the recording processor **161** with recorded data read by the first optical pickup unit **50** at each address. If a write error is found, the system controller **152** will control the second pickup moving mechanism **120** to detect an address where the error has occurred and the second optical pickup unit **100** will resume the writing once suspended.

Note here that in a disk drive including only one optical pickup unit, if there has occurred a failure in write to the signal recording surface of the disk-shaped recording

medium **3**, it is verified, after all content data have completely been written to the disk-shaped recording medium **3**, whether the content data have successfully been written, which will take a long time for the verifying operation, and no rapid resumption of writing will thus be possible. However, the simultaneity between data write by the second optical pickup unit **100** and verification by the first optical pickup unit **50** as in the disk drive **1** according to the present invention makes it possible to rapidly detect any write error and resume the writing once suspended.

Therefore, the disk drive **1** can rapidly write data and resume write to a disk-shaped recording medium **3** to which data can be continuously written time-serially, such as a CD-R, DVD-R or the like.

Also, the first and second optical pickup units **50** and **100** are moved between the inner and outer radii of the disk-shaped recording medium **3** when it is going to write or read, as shown in FIGS. **7** and **8**. Since the outer dampers **141** to **144** and inner dampers **145** and **146** are installed at opposite ends, respectively, of the mount **24** formed near the comers and at the longitudinal middle of base chassis **12** and the base chassis **12** is supported on the upper and lower frames **18** and **19** of the base frame **10** via the dampers **141** to **146**, so it is possible to effectively isolate the first and second optical pickup units **50** and **100** from the vibration of the spindle motor **42** on the base chassis **12**.

More specifically, when the first and second optical pickup units **50** and **100** are moved to the inner radius of the disk-shaped recording medium mounted on the disk table, namely, in a direction in which they are nearer to the spindle motor **42** as the source of vibration, they will be surrounded along with the spindle motor **42** by the outer dampers **141** and **142** or **143** and **144** and inner dampers **145** and **146** and thus it is possible to more effectively isolate the first and second optical pickup units **50** and **100** from the vibration of the spindle motor **42**. Also, when the first and second optical pickup units **50** and **100** are moved to the outer radius, that is, in a direction in which they are away from the spindle motor **42**, they will be surrounded by at least three dampers including the pair of outer dampers **141** and **142** or **143** and **144** and the inner damper **145** or **146** and thus it is possible to prevent the first and second optical pickup units from being influenced by the vibration of the spindle motor **42**.

In the foregoing, the present invention has been described in detail concerning certain preferred embodiments thereof as examples with reference to the accompanying drawings. However, it should be understood by those ordinarily skilled in the art that the present invention is not limited to the embodiments but can be modified in various manners, constructed alternatively or embodied in various other forms without departing from the scope and spirit thereof as set forth and defined in the appended claims.

Namely, the present invention is not limited to the disk drive **1** having been described in the foregoing but the first optical pickup unit **50**, for example, may be designed to write and/or read data. In the above disk device **1**, the disk-shaped recording medium **3** is inserted directly into the device body **2**, but the present invention is not limited to this design. The disk device **2** may be designed to have a disk tray which is formed movable into and out of the device body **2** so that a disk-shaped recording medium **3** can be placed on the disk tray and carried as it is into the device body **2**.

What is claimed is:

1. A disk drive comprising:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the disk-shaped recording medium;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to only read information signals recorded in a first disk-shaped recording medium of a first type set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit in a direction radial to the first disk-shaped recording medium;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write information signals to and read information signals from a second disk-shaped recording medium of a second type set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit in a direction radial to the second disk-shaped recording medium;

a skew detecting means for detecting an inclination of an optical axis of light emitted from the second optical pickup unit in relation to the second disk-shaped recording medium; and

a skew adjusting means for adjusting a skew of the second optical pickup unit writing or reading information signals to or from the second disk-shaped recording medium by adjusting an inclination of the second optical pickup unit correspondingly to the optical axis inclination detected by the skew detecting means.

2. The disk drive according to claim **1**, wherein:

the base chassis has provided thereon a sub chassis having the second optical pickup mechanism disposed thereon opposite to the first optical pickup mechanism across the disk rotation drive; and

the sub chassis has the inclination thereof adjusted by the skew adjusting means to make a skew adjustment of the second optical pickup unit.

3. The disk drive according to claim **1**, further comprising a verifying means for verifying, by the first optical pickup mechanism, when the second optical pickup mechanism is writing information signals to the second disk-shaped recording medium, whether the information signals have successfully been written.

4. The disk drive according to claim **1**, wherein the sub chassis has formed therein a movement opening in which the second optical pickup unit is movable in a direction radial to the second disk-shaped recording medium, and has also formed thereon a coupling member to couple opposite ends of the movement opening to each other in a direction perpendicular to a moving direction of the second optical pickup unit.

5. A disk drive comprising:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the disk-shaped recording medium;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to read information signals from a first disk-shaped recording medium of a first type set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit in a direction radial to the first disk-shaped recording medium;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write information signals to and read information signals from a second disk-shaped recording medium of a second type set on the disk table,

and a second pickup moving mechanism that moves the second optical pickup unit in a direction radial to the second disk-shaped recording medium;

a skew detecting means for detecting an inclination of an optical axis of light emitted from the second optical pickup unit in relation to the second disk-shaped recording medium;

a skew adjusting means for adjusting a skew by adjusting an inclination of the second optical pickup unit correspondingly to an inclination of the optical axis, detected by the skew detecting means; and

a detecting means for detecting by the second optical pickup unit a type of a disk-shaped recording medium inserted into the disk drive.

6. The disk drive according to claim **5**, wherein:

the base chassis has provided thereon a sub chassis having the second optical pickup mechanism disposed thereon opposite to the first optical pickup mechanism across the disk rotation drive; and

the sub chassis has an inclination thereof adjusted by the skew adjusting means to make a skew adjustment of the second optical pickup unit.

7. A disk drive comprising:

a base chassis;

a disk rotation drive including a disk table disposed on the base chassis to hold a disk-shaped recording medium and a spindle motor coupled to the disk table to rotate the disk-shaped recording medium;

a first optical pickup mechanism including a first optical pickup unit disposed on the base chassis to read information signals from a first disk-shaped recording medium of a first type set on the disk table, and a first pickup moving mechanism that moves the first optical pickup unit in a direction radial to the first disk-shaped recording medium;

a second optical pickup mechanism including a second optical pickup unit disposed opposite to the first optical pickup mechanism to write information signals to and read information signals from a second disk-shaped recording medium of a second type set on the disk table, and a second pickup moving mechanism that moves the second optical pickup unit in a direction radial to the second disk-shaped recording medium;

a skew detecting means for detecting an inclination of an optical axis of light emitted from the second optical pickup unit in relation to the second disk-shaped recording medium;

a skew adjusting means for adjusting a skew by adjusting an inclination of the second optical pickup unit correspondingly to an inclination of the optical axis, detected by the skew detecting means; and

a detecting means for detecting by the first optical pickup unit a type of a disk-shaped recording medium inserted into the disk drive.

8. The disk drive according to claim **7**, wherein:

the base chassis has provided thereon a sub chassis having the second optical pickup mechanism disposed thereon opposite to the first optical pickup mechanism across the disk rotation drive;

the sub chassis has an inclination thereof adjusted by the skew adjusting means to make a skew adjustment of the second optical pickup unit.

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